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(54) Automatic testing of a plurality of smoking articles.

(57) A flexible automatic test facility for measuring physical parameters or smoking articles and components of smoking articles, e.g., filter portions is disclosed. The test facility includes a microprocessor based controller device 1000, means 300 for severing the filter portion from the article, a plurality of instruments 200, 600, 700, 800, 850 for performing the desired measurements and a computer-controlled robot 503 for gripping and maneuvering one cigarette at a time to one or more of the instruments or severing means to measure one or more physical characteristics of each article or its components in accordance with software instructions. A hopper feeder 100 device containing a plurality of sample sets in separate bins in an indexing mechanism may be provided for extended unattended operation. Each sample set is provided with a code and a database including the nominal physical characteristics of the samples in the set and the test sequence for the cigarettes in the sample set. The test sequence and paratmeters for each article in each set are obtained from the database, and the controller instructs the robot to grip a fed cigarette and to advance that cigarette to one or more of the instruments for performing measurements processing station for severing filter in accordance with the predetermined sequence of measurements. At the conclusion of the samples in a given sample set, the next sample set is loaded, identified, and the process continues in accordance with the predetermined sequence for that sample set.

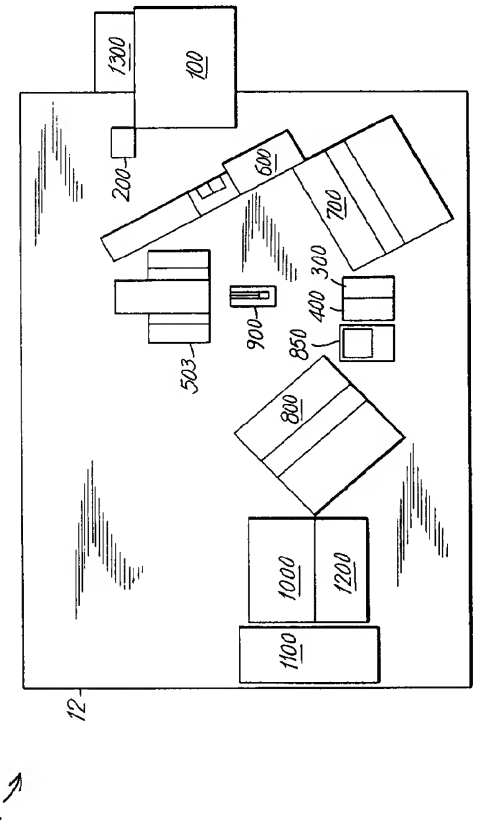

FIG. 1

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Background of the Invention

This invention relates to an automatic test station for handling bundles of smoking articles and performing one or more of a plurality of physical measurements on individual smoking articles and components thereof. More particularly, this invention relates to an automatic test station having a plurality of measuring stations and a robotic device for maneuvering differently dimensioned smoking articles to one or more of the measuring stations in a preselected sequence in an unattended mode.

It is common practice to perform a sequence of one or more tests or measurements on commercial and experimental smoking articles and their component parts following assembly. These measurements include the physical characteristics of the article and component parts (e.g., the filter) such as article pressure drop, ventilation, filter pressure drop, article circumference, article length, filter length, filter and tobacco weights, and paper permeability. A plurality of like smoking articles are subjected to tests that measure one or more of those specific properties. The test results may be used to evaluate the uniformity of the measured property or properties from article to article within the plurality of like articles and to obtain statistical data regarding the characteristics of the like articles in that plurality of articles. In addition, multiple pluralities of like articles, wherein the articles in each plurality may be different, are typically subjected to the same series of tests under conditions that permit comparing the statistical characteristics of the different like articles.

Tests may be performed both on the complete article and separately on components of a complete article. For example, the filter portion of a filter-tipped smoking article may be measured for pressure drop, circumference and size. This requires that the filter be severed from the smoking article. Any tobacco shreds that remain affixed to the filter are removed from the filter portion.

In conventional testing, a series of conventional test insert ents are arranged in a work area. An operator manually places each smoking article, or its component, into each instrument and actuates the insert ent to conduct the desired measurement. The test result, i.e., the measured parameter is then displayed on the insert ent and the data are typically transmitted to a host computer for recordation in a database. The database is used for subsequent analysis and tabulation. To measure component parts, the operator must manually sever the component from the article, dispose of the remainder of the article (or save it for subsequent testing), and then insert the component into the proper instrument or instruments to acquire the desired measurements. For example, to conduct tests on the filter rod portion of a conventional cigarette, the filter rod is typically severed from the cigarette using a razor blade to cut through the tobacco portion, and any tobacco shreds remaining attached to the filter are removed by the operator using a small instrument or a finger. The cleaned or deshredded filter is then inserted into the measuring insert ents and the data acquired.

One problem with this technique is that it requires an operator to be in attendance throughout the procedure. Tests on manually guided articles also may be subject to variations in how or where the smoking article is gripped and/or positioned during the measurement procedure. These variations are undesirable for obtaining accurate statistical data.

Fidus-Instrument Corporation, Richmond, Virginia, has available a product line under the trade name Automatic Test Stations. The automatic test stations provide combinations of instruments for measuring one or more of weight, circumference/diameter, ventilation, pressure drop, and hardness. Model numbers CTS 500, CTS 400, CTS 350, and CTS 300 are automatic test stations for testing only cigarettes. Model numbers FTS 400 and FTS 300 are automatic test stations for testing only filter rod portions. The different numerical designations indicate that different combinations of instruments for performing various measurements are combined into a single CTS or FTS station. The measuring units are stacked on top of each other so that each article or filter rod to be tested is downwardly and sequentially indexed along an axis through the instruments.

The automatic test stations are available in conjunction with a product under the trade name Automatic Hopper Loader, model number AHL 100, also available from Fidus Instrument Corp. The Automatic Hopper Loader device has a plurality of bins for receiving bundles of a plurality of smoking articles (or filter rods) that may be loaded with up to eighteen bundles of smoking articles (or filter rods) simultaneously. The commercial hopper device transfers the contents of one bin to a hopper area. The contents loaded in the hopper area are then fed, one at a time, into either a CTS or FTS device, to which the hopper is mated. The bins are then indexed to bring the next bin into position for unloading into the hopper. The CTS and FTS automatic test station devices are capable of providing the results of the acquired test data to a master computer for tabulation and recordation.

One problem with these prior commercial devices is that they are not sufficiently flexible to alter the test sequence of individual samples among each bundle or from bundle to bundle. Rather, each model Automatic Test Station is configured with a sufficiently broad number of tests which are performed on each smoking article or filter rod fed into the Station. Thus, unnecessary tests are performed. Also, if one insert ent module in a station becomes inoperative, the entire station becomes inoperative until that module can be repaired or replaced.

Another problem with these prior devices is that they are not capable of performing tests on a selected

smoking article, followed by performing tests on a component of that smoking article, for example, the filter rod portion. Rather, a second Automatic Test Station of the FTS series must be obtained, in addition to a CTS series station, and an operator must manually sever the filter from the smoking articles measured by the CTS station and insert the severed filters into the FTS station for the filter measurements.

It is known to use robotic devices having opposing members for grasping and maneuvering objects from one location to another for assembling structures and for preparation of samples, e.g., dilution or mixing of chemical materials, prior to introduction to an analytical instrument in an analytical laboratory. One such device is the MasterLab™ System available from Perkins-Elmer Corp., Norwalk, CT 06856. However, it is not known to use such devices for gripping and maneuvering a plurality of different smoking articles. One of the problems with such robotic systems is that they are not readily capable of grasping differently dimensioned crushable, nonresilient objects such as smokng articles without damaging at least some, if not all, of such articles. More particularly, such robotic devices typically do not have the ability to grasp securely a preselected range of differently dimensioned smoking articles without deforming at least some articles in the range. The use of force transducers to monitor the forces exerted to control gripping of the article has been considered. However, such transducers increase the cost and complexity of the device. Also, because such transducers monitor force, they do not detect whether the deformable article is securely gripped and not deformed or damaged. Thus, such force transducers are not likely to prevent the opposing members from damaging relatively fragile smoking articles.

Accordingly, there is a continuing need for automatic test stations that are flexible in operation and can be programmed to perform a desired series of tests of measurements. Further, there is a need for such automatic test station that can operate in an unattended mode.

It has, therefore , been desired to provide an automated test station for obtaining one or more measurements on a smoking article selected from among a plurality of possible measurements. It is another object to provide a programmable automated test station for conducting different tests on different smoking articles in an unattended mode. It has also been desired to provide an automated test station that can conduct measurement tests on multiple sets of samples consecutively in an unattended mode.

It has also been desired to provide an automatic test station that can perform a selected sequence of characterization measurements on a smoking article and on a component of that article. It has also been desired to provide a robotic device for gripping and maneuvering each smoking article and smoking article component.

It has also been desired to provide an automated test station that can be instructed to conduct different test protocols on different samples within a sample set and on samples within different sample sets.

It has also been desired to provide an automated test station that can conduct measurement tests using conventional measuring instruments with minimal modification. It has also been desired to provide a test station that can be manually operated when necessary or desirable.

It has also been desired to provide an automated test station that can communicate with a computer device to receive information regarding the tests to be conducted and to transfer data for subsequent evaluation.

Summary of the Invention

In accordance with the present invention, a computer-controlled robotic automatic test station that measures a selected number of a plurality of physical parameters of smoking articles and/or smoking article components in a selected sequence is provided.

One aspect of the present invention is directed to an apparatus for measuring a physical characteristic of a plurality of smoking articles. One such apparatus comprises:

means for gripping and releasing a smoking article;

means for maneuvering a gripped smoking article within a range of motion;

means for receiving one of said plurality of smoking articles at a first location within the range of motion;

means for measuring a physical characteristic of a smoking article, the measuring means being at a second location within the range of motion; and

means for controlling the gripping and releasing means and the maneuvering means to grip the one smoking article at the first location and to maneuver the one smoking article to the measuring means so that the physical characteristic of the one smoking article can be measured.

In one embodiment, the controlling means is a microprocessor which controls the gripping and releasing means to release the one smoking article at the measuring means so that the physical characteristic can be measured and to grip the one smoking article at the measuring means following the measurement. Preferably, the gripping and releasing means and the maneuvering means are a robot having a first member and a second member, the first and second members being movable in opposition for gripping therebetween a smoking article.

In a preferred embodiment of such an apparatus, the measuring means further comprises a first means for measuring a first physical characteristic of a smoking article located at the second location and a second means for measuring a second physical characteristic of a smoking article, the second measuring means being located at a third location within the range of motion, and wherein the controlling means controls the gripping and releasing means and the maneuvering means to grip the one smoking article at the first location and to maneuver the one smoking article to one of the first and second measuring means whereby one of the first and second physical characteristics can be measured. The controlling means preferably also controls the gripping and releasing means and the maneuvering means to maneuver the one smoking article from the one of the first and second measuring stations to the other of the first and second measuring means whereby the other of the first and second physical characteristics can be measured.

In an alternate preferred embodiment of such an apparatus, the measuring means further comprises more than one means for measuring more than one selected physical characteristics of a smoking article wherein each said means is located at a different location within the range of motion and measures a different physical characteristic, said means being selected from among the group consisting of means for measuring circumference, means for measuring pressure drop and means for measuring length, and for filter-tipped smoking articles, means for measuring ventilation, and wherein the controlling means controls the gripping and releasing means and the maneuvering means to maneuver the one smoking article to one or more of the measuring means. The controlling means preferably further comprises a means for providing a test sequence identifying one or more physical characteristics of the one smoking article to be measured, wherein the controlling means is responsive to the test sequence and controls the gripping and releasing means and the maneuvering means to maneuver the gripped one smoking article to one or more of the measuring means so that the one or more identified physical characteristics can be measured. In a preferred embodiment, the test sequence identifies the order in which the measurements of the one smoking article are to be made, and more preferably the order in which the measurements of each smoking article in the plurality of smoking articles are to be made.

Another aspect of the present invention is directed toward an apparatus for measuring a physical characteristic of a component of a plurality of smoking articles. One such apparatus includes:

means for gripping and releasing a smoking article;

means for maneuvering a gripped smoking article within a range of motion;

means for receiving one of said plurality of smoking articles at a first location within the range of motion;

means for severing the component of the smoking article from the smoking article, the severing means being located at a second location within the range of motion;

means for measuring a physical characteristic of a smoking article component, the measuring means being at a third location within the range of motion; and

means for controlling the gripping and releasing means and the maneuvering means to grip the one smoking article at the first location and maneuver the one smoking article to the severing means, and to maneuver the one smoking article component to the measuring means so that the physical characteristic of the one smoking article component can be measured.

In one embodiment, the controlling means is a microprocessor which controls the gripping and releasing means to grip the one smoking article by its component, release the one smoking article component at the measuring means so that the physical characteristic of the one smoking article component can be measured, and grip the one smoking article component at the first measuring means following the measurement. Preferably, the gripping and releasing means and the maneuvering means are a robot having a first member and a second member, the first and second members being movable in opposition for gripping therebetween a smoking article.

In a preferred embodiment of such an apparatus, the measuring means comprises a first measuring means for measuring a first physical characteristic of a smoking article component located at the third location and a second means for measuring a second physical characteristic of a smoking article component, the second measuring means being located at a fourth location within the range of motion, and wherein the controlling means controls the gripping and releasing means and the maneuvering means to grip and maneuver the one smoking article component to one of the first and second measuring means whereby one of the first and second physical characteristics can be measured. The controlling means preferably controls the gripping and releasing means and the maneuvering means to maneuver the one smoking article component from the one of the first and second measuring stations to the other of the first and second measuring means whereby the other of the first and second physical characteristics of the smoking article component can be measured. The first and second measuring means are preferably selected from among the group consisting of means for measuring ventilation, means for measuring pressure drop, and means for measuring length.

In an alternate preferred embodiment of such an apparatus, the measuring means further comprises a first means for measuring a first physical characteristic of a smoking article component and a second means for

measuring a second physical characteristic of a smoking article, the second measuring means being at a fourth location within the range of motion, wherein the controlling means controls the gripping and releasing means and the maneuvering means to grip the one smoking article at the first location, to maneuver the one smoking article to the second measuring means so that the first physical characteristic of the one smoking article can be measured, and then to the severing means, thereby to sever the component, and to maneuver the one smoking article component to the first measuring means so that the first physical characteristic of the one smoking article component can be measured.

Alternately, the first measuring means further comprises more than one means for measuring more than one physical characteristic of a smoking article component at more than one location in the range of motion, the second measuring means further comprises more than one means for measuring more than one physical characteristic of a smoking article located at more than one location in the range of motion, and the controlling means further comprises a means for providing a test sequence identifying one or more physical characteristics of the one smoking article and one or more physical characteristics of the one smoking article component to be measured, wherein the controlling means is responsive to the provided test sequence and controls the gripping and releasing means and the maneuvering means to maneuver the gripped one smoking article to one or more of the second measuring means, and the severing means, and one or more of the first measuring means so that the one or more identified physical characteristics of the smoking article and the smoking article component can be measured. The test sequence may identify the order in which the measurements of the one smoking article component are to be made and more preferably the order in which the measurements of each smoking article component of the plurality of smoking article are to be made. The physical characteristics of a smoking article are obtained prior to the physical characteristics of a smoking article component.

In one embodiment, the apparatus includes a second means for receiving a smoking article at a fifth location within the range of motion wherein the microprocessor means controls the gripping and releasing means and the maneuvering means to release the one smoking article onto the second receiving means and then to grip the smoking article by its component on the second receiving means, to maneuver the one smoking article to the severing means, and to grip the one smoking article component during the severing process. Preferably, each smoking article component is a filter rod of a cigarette and the apparatus further comprises a means for deshredding the severed filter component of a cigarette, wherein the microprocessor means controls the gripping and releasing means and the maneuvering means to maneuver a severed filter to the deshredding means following the severing operation.

Another aspect of the present invention is directed toward a method for measuring a physical characteristic of a plurality of smoking articles at a test station having a means for gripping and releasing a smoking article, means for maneuvering a gripped smoking article within a range of motion, means for receiving one of said plurality of smoking articles at a first location within the range of motion, means for measuring a physical characteristic of a smoking article, the measuring means being at a second location within the range of motion; and microprocessor means for controlling the gripping and releasing means and the maneuvering means. One such method comprises the steps of providing a plurality of smoking articles;

feeding one fed smoking article to the receiving means;

gripping the one smoking article at the receiving means;

maneuvering the gripped one smoking article to the measuring means; aid

measuring the physical characteristic of the one smoking article.

In an alternate embodiment the method includes releasing the one smoking article at the measuring meals so that the physical characteristic can be measured aid gripping the one smoking article at the first measuring meals following the measurement.

Preferably, the gripping aid releasing meals aid the maneuvering meals are a robot having a first member aid a second member movable in opposition, and gripping aid releasing the one smoking article further comprises moving the first aid second members together for gripping a smoking article and moving the first and second members apart to release the smoking article.

In yet another embodiment, wherein the test station includes more than one means for measuring more than one selected physical characteristics of a smoking article and each said means is located at a different location within the range of motion, said means being selected from among the group consisting of means for measuring circumference, means for measuring pressure drop and means for measuring length, the method further comprises the steps of:

providing a test sequence identifying one or more physical characteristics of the one smoking article to be measured;

gripping and maneuvering the one smoking article to one or more of the measuring means in response to the provided test sequence so that the one or more identified physical characteristics can be measured. Preferably, providing the test sequence further comprises identifying the order in which the measurements of the

one smoking article are to be made, and more preferably, identifying the order in which the measurements of each smoking article in the plurality of smoking articles are to be made.

Another aspect of the present invention is directed towards a method for measuring a physical characteristic of a component of a plurality of smoking articles in a test station having means for gripping and releasing a smoking article, means for maneuvering a gripped smoking article within a range of motion, means for receiving one of said plurality of smoking articles at a first location within the range of motion, means for severing the component of a smoking article from the smoking article, the severing means being located at a second location within the range of motion, means for measuring a physical characteristic of a smoking article component, the measuring means being at a third location within the range of motion, and microprocessor means for controlling the gripping and releasing means and the maneuvering means. One such method comprises:

providing a plurality of smoking articles;
feeding one smoking article to the receiving means;
gripping the one fed smoking article by its component;
maneuvering the gripped smoking article to the severing means;
severing the one smoking article component from the one smoking article;
maneuvering the one smoking article component to the measuring means; and
measuring the physical characteristic of the one smoking article component.

Optionally, the method further comprises releasing the smoking article component at the measuring means so that the physical characteristic of the one smoking article component can be measured and gripping the one smoking article component at the measuring means following the measurement.

Preferably, the gripping and releasing means and the maneuvering means are a robot having a first member and a second members movable in opposition and the step of gripping the one smoking article or one smoking article component further comprises moving the first and second members together and the step of releasing the one smoking article component further comprises moving the first and second members apart.

In one preferred embodiment, the measuring means further comprises one or more means for measuring one or more physical characteristics of a smoking article component selected from among the group consisting of means for measuring ventilation, means for measuring pressure drop and means for measuring length, and one or more means for measuring one or more physical characteristics of a smoking article, each measuring means being located at a different location within the range of motion, wherein the method further comprises:

providing a test sequence identifying one or more of the physical characteristics of the one smoking article and the one smoking article component to be measured;

gripping and releasing and maneuvering the one smoking article to one or more of the measuring means and the severing station in response to the identified sequence so that the one or more of the identified physical characteristics of the one smoking article and the one smoking article component can be measured.

Preferably, providing the test sequence further comprises identifying the order in which the measurements of the one smoking article and the one smoking article component are to be made, and more preferably the order in which the measurements of each smoking article and smoking article component of the plurality of smoking articles are to be made.

In one preferred embodiment, the test station includes a second means for receiving a smoking article at a fourth location within the range of motion and the step of maneuvering the gripped one smoking article to the severing means further comprises:

maneuvering the gripped article to the second receiving means,
releasing the one smoking article on the second receiving means;
gripping the one smoking article component while the article is on the second receiving means; and
maneuvering the one smoking article to the severing means so that the gripping means grips the one smoking article component during the severing process.

Preferably, the smoking article and its component further comprise a tobacco-containing cigarette and a filter tip and the method further comprises:

maneuvering the gripped filter severed from the cigarette to a means for deshredding the filter of any tobacco prior to measuring the physical characteristic of the filter, the deshredding means being at a fifth location in the range of motion.

In one aspect, the invention concerns providing a robot, a system microprocessor controller, a selected number of misting laboratory measuring instruments, and a smoking article severing station. The microprocessor device controls the robot, instruments, and severing station so that each article or component to be tested is maneuvered through a predetermined sequence of tests. A hopper feeder device may be provided so that several sets of samples can be loaded at one time into separate bins in that device whereby each sample set is identified with a code and the physical parameters of the samples in each set are enumerated and assigned to that code. In addition, the sequence of the tests to be run on the samples in the set and which tests are to

be run on which samples are established in a database that is associated with the code. Thus, when a bin of samples is to be processed, the code is read and the appropriate database parameters are incorporated into the instructions to the robot so that samples are properly maneuvered into the proper position for conducting the selected measurements to be performed in the selected sequence.

In operation, the system controller instructs the hopper-feeder to unload one hopper-bin containing a sample set into a feeder device and to feed one article from that set at a time. The system controller reads the code associated with that bin and sample set and adjusts the instructions to be delivered to the robot to account for the parameters of the samples to be measured and the tests sequence to be conducted. The system controller then instructs the robot to grip an article and place it into the selected test instruments in the selected sequence, to obtain the test results and data, optionally to print the data, and preferably to transmit the acquired data to a host computer for further processing. The system controller counts the number of samples processed and advances the hopper feeder to unload another sample set for the next test sequence.

Advantageously, in the present invention, a flexible automatic test station is provided which can increase overall productivity by allowing the system operator to perform other duties or tests that are not susceptible to robotic controlled performance while the test station is processing multiple sample sets. These duties also could include reviewing test data and loading additional sample sets into the station. Also, a station in accordance with the present invention can be operated in an unattended mode, and thus can conduct tests after regular work hours to accommodate peak work loads without requiring training of additional operators to conduct the tests manually. In addition, because the test station uses conventional instruments, those instruments can be manually used when the automatic feature of the test station is not being used. Another advantage to the flexible test station of the present invention is that it can be modified as needed by the addition or deletion of various measuring instruments (modified for remote microprocessor control). Yet another advantage is that if one instrument becomes inoperative, the test station may stop operation and alert an attending operator or, if unattended, skip the inoperative instrument and continue to perform the other tests on the samples in the sample sets.

Brief Description of the Drawings

Further features of the invention, its nature and various advantages will be more apparent from the accompanying drawings and the following detailed description of the invention, in which like reference numerals refer to like elements, and in which:

FIG. 1 is a schematic top plan view of the present invention;
FIG. 2 is front view of the hopper feeder and length measuring station of FIG. 1;
FIG. 3 is a side view taken along line 3-3 of FIG. 1;
FIG. 4 is a top view taken along line 4-4 of FIG. 2;
FIG. 5 is a side sectional view taken along line 5-5 of FIG. 2;
FIG. 6 is a representative view of one embodiment of the field of view of the length measuring station;
FIG. 7 is a representative view of a second embodiment of the field of view of the length measuring station;
FIG. 8 is a front sectional view of severing station 300 of FIG. 1;
FIG. 9 is a side view taken along line 9-9 of FIG. 8;
FIG. 10 is a partial sectional view of the deshredding station of FIG. 1;
FIG. 11 is a side view of the deshredder tool of FIG. 1;
FIG. 12 is an end view taken along line 12-12 of FIG. 11
FIG. 13 is a front plan view of the gripping mechanism of FIG. 21;
FIG. 14 is a side view taken along line 14-14 of FIG. 13;
FIG. 15 is a side view taken along line 15-15 of FIG. 13;
FIG. 16 is a front view taken along line 16-16 of FIG. 15;
FIG. 17 is a side view of a grasping member taken along line 17-17 of FIG. 13;
FIG. 18 is a front view taken along line 18-18 of FIG. 17;
FIG. 19 is a partial sectional view taken along line 19-19 of FIG. 13;
FIG. 20 is a front view taken along line 20-20 of FIG. 19;
FIG. 21 is an elevated perspective view of the robot of FIG. 1;
FIG. 22 is an side view of the reorientation fixture of FIG. 1;
FIG. 23 is an end view taken along line 23-23 of FIG. 22; and
FIG. 24 is top view taken along line 24-24 of FIG. 22.

Detailed Description of the Invention

Referring to FIG. 1, station 10 in accordance with a preferred embodiment of the invention includes table

12, robot 503, hopper-feeder 100, station 200 for measuring the length of an article, circumference station 600 for measuring the circumference of the smoking article, PDI station 700 for measuring the smoking article pressure drop and filter ventilation, fixture 900 for reorienting a smoking article, severing station 300 for severing an article component from the article, deshredding station 400 for removing tobacco shreds film the severed component, PDI 800 for measuring the filter pressure drop, station 850 for measuring the length of a filter, and microprocessor 1000 for controlling the operation of station 10. Associated with station 10 is host coomputer 1200 for containing test protocols and paramaters in a database listing and acquiring test data for for tabulation, evaluation and analysis. Additionally, station 10 includes operator workstation 10.

Table 12 is preferably a flat table for supporting the various devices, insert instruments, and processing stations at positions within the reach of robot 503. Table 12 is sufficiently large, e.g., 1.5m by 2m (five feet by seven feet), to restrict an operator from interfering with the motion of robot 503 and either injuring the operator or halting the motion of the robot.

Referring to FIGS. 1-5, hopper feeder 100 has a plurality of pockets 110 attached to a continuous belt 120 that travels around sprockets 122. In one embodiment, belt 120 is indexed to advance the plurality of pockets 110 a distance corresponding to the spacing between each pocket. In the preferred embodiment, each pocket 110 is capable of containing a sample set of a plurality of smoking articles 20, for example, up to thirty articles, preferably of the same type or brand. Each pocket 110 will typically contain a sample set of a plurality of like articles 20 that may be the same or different from each sample sets in other pockets.

An unloading device 130 is positioned at a selected location relative to the path of belt 120 so that as one of pockets 110 is indexed into alignment with device 130, the contents of the one pocket are transferred from that pocket into device 130. Unloading device 130 may be a paddle or flange that pushes the articles out of pocket 110 or alternatively manipulates pocket 110 to release its contents. Referring to FIG. 2, device 130 moves from an extreme left position to an extreme right position in a range of travel. One pocket 110 is indexed into alignment with device 130, which is then moved from its extreme right position to its extreme left position, thereby pushing articles 20 out of the one pocket 110 and into a feed mechanism 140.

Feed mechanism 140 dispenses the articles in device 130 one at a time into chute 220. One such feed mechanism 140 may be, for example, a V shaped feed structure 150 having an aperture 152 at the vertex so that articles 20 are fed through the vertex aperture one at a time, and a device for receiving one article at a time for transferring that article to chute 220 (not shown). Preferably, the plurality of articles 20 in pockets 110 are longitudinally aligned with chute 220 so that no angular manipulation is required.

Hopper feeder 100, unloading device 130, and feed mechanism 140 are preferably a commercial device, for example, model AHL 100, purchased from Fidus Instrument Corporation. The commercial device is constructed with a funnel type feed mechanism for feeding the contents that are unloaded from a pocket one at a time, in a vertical direction downwardly, to an interconnected commercial CTS or FTS test station. For adaptation for use with the present invention, the conventional funnel mechanism was removed and the commercial hopper feeder device was installed at one edge of table 12 proximate to chute 220 so that chute 220 receives at an angle each article 20 as it is fed out the feed mechanism provided with the commercial device. Thus, each article 20 slides down chute 220 at an angle to horizontal.

The commercial device also was modified by the addition of feet (not shown) so that it would stand on the floor. Hopper system 100 as purchased contained motor drive electronics and controls that connected directly to a computer. This required that the computer send a pulse to the stepping motor each time belt 120 was moved, requiring 16,000 pulses to index from one pocket 110 to the next. To offload computer 1000 from this task and so that computer 1000 may be used for other potential tasks, a commercial preset indexer was added (not shown). This device is programmed to generate the required number of pulses when computer 1000 toggles a digital input on the indexer. The indexer is capable of generating the control signals for device 130, thus offloading control computer 1000. The digital input on the present indexer can also be toggled using a pushbotton, allowing manual control of the system 100. This manual control may be used for set-up and adjustments to system 100 and for troubleshooting, all without use of computer 1000. The as purchased control of feed mechanism 140 likewise required computer control to monitor the index detector, to determine when to stop the motor driving device 140. Hopper system 100 was similarly modified to work independently, turning the feed mechanism one revolution and stopping automatically whenever a digital input is toggled to start the motor rotation.

Referring to FIGS. 1 and 13-21, robot 503 includes base 590, rotating platform 591, pivoting member 592, pivoting arm 593, hand 500, and opposing members 510 and 520. Base 590 provides base rotation in the horizontal plane of robot 503 about an axis and is secured to table 12. Pivoting member 592 provides for shoulder joint movement by rotating in a two dimensional vertical plane. Pivoting member 593 provides for elbow joint movement by rotation in a two dimensional vertical plane. Hand 500 provides a wrist pitch motion and wrist rotation motion in three dimensions. Hand 500 includes means for translating a pair of opposing members 510

and 520 for gripping one smoking article 20 toward and away from each other so that the opposing members contact and grip article 20 securely without deforming article 20.

Robot 503 preferably has five independently controlled axes with position repeatability of +/- 0.5 mm, and a maximum reach in the range of from about 600mm to 700mm (24 to 27 inches). Robot 503 is controlled by microprocessor 1000 and is thus capable of operating unattended and repeatedly performing each of the possible sequences or processes with the same accuracy and precision. Because it is a software controlled device, robot 503 can be controlled by appropriate programming to perform a sequence of motions which may be the same or different for each article that is gripped and maneuvered as described below.

Robot 503 is preferably a model Movemaster 11, manufactured by Mitsubishi, Inc., of Japan, and available from Perkin-Elmer Corporation as part of a product known as the MasterLab™ System. The MasterLab™ device includes as microprocessor 1000 an IBM PC computer, model AT, having an Intel 8088 microprocessor device, 286 kilobyte memory, and software appropriate to control the initialization and motion of robot 503 relative to base 590 in the five dimensions and, thus, relative to each of the stations with which robot 503 interacts as described herein. The software for controlling the motion of the robot uses the commercial known programming language PERL (Perkin-Elmer Robot Language), which is a menu driven language having a dedicated command structure. Microprocessor 1000 also is provided with appropriate and conventional data communication ports to control the various test instruments to perform the desired measurements when the smoking article or the filter portion or other component is inserted into the measuring station, and to receive test data obtained. Appended hereto as a software appendix is a software listing for operation of robot 503 of automatic test station 10 in accordance with the present invention.

Referring to FIGS. 13-20, a preferred embodiment of the opposing gripping members of robot 503, in accordance with the present invention, are shown. First member 510 is secured to flange 501 and support member 560 (and hence member 520) is secured to corresponding flange 502 so that members 510 and 520 are generally disposed in relatively fixed angular orientations, e.g., in parallel, and have opposing respective inner surfaces 511 and 521. Force altering means 570 is connected to support member 560 and second member 520. It provides for moving member 520 relative to support 560 to alter or adjust the force exerted on gripped smoking article 20, thereby to maintain the force below the force that would otherwise be imposed on smoking article 20 if there was no such movement, and below a selected maximum force that might crush or deform article 20.

In the preferred embodiment, force altering means 570 includes lever 530, spring 540, stop 550, and pin 563. Lever 530 is secured at one end to member 520 by bolt 531. Spring 540 is set within receptacle 541 milled in support 560 and urged against lever 530. Member 520 is pivotally secured to support 560 between yokes 561 and 562 about pin 563. Stop 550 is adjustably secured to support 560 so that it extends a selected distance from support 560. Stop 550 includes a flange 551 that is configured to fit over end 533 of lever 530. Spring 540 thus urges lever 530 against stop 550 flange 551. The range of motion of lever 530, and hence member 520, is limited by the motion of lever end 533 between support 560 and stop 550 as lever 530 pivots about pin 563. The position of stop 550 is adjustable to control the range of motion and is typically set so that member 520 is normally biased parallel to member 510 when not in contact with any article 20. Stop 550 also is used to keep member 520 from over-extending towards member 510 due to the force that spring 540 exerts on lever 530.

In an alternate embodiment, stop 550 could be adjusted so that tip 522 is biased closer to tip 512 than yokes 561 and 562 are spaced to member 510. This provides for gripping a slightly greater range of differently dimensioned articles as compared to when members 510 and 520 are biased parallel, but makes positioning members 510 and 520 about each article more difficult, requiring a comparatively larger distance between members 510 and 520 in the open position. Similarly, member 570 could be adjusted so that some of the force that would otherwise be exerted by members 510 and 520 on article 20 is altered when each article in this preselected range of differently dimensioned articles is gripped.

Member 520 has a notch 525 cut in surface 521 near tip 522 and member 510 has a corresponding notch 515 cut in opposing surface 511 near its tip 512. Notches 515 and 525 are thus in opposition for gripping a smoking article 20 therebetween. Notches 515 and 525 each preferably comprises two planar surfaces that intersect at an angle α of approximately 90 degrees. Further, the notches are arranged to form a receptacle for receiving and supporting article 20.

The shape and dimension of notches 515 and 525 are chosen so that a preselected range of dimensions of differently dimensioned smoking articles 20 can be supported and securely gripped by opposing forces exerted by members 510 and 520. Differently dimensioned articles thus may have different contact points on the respective planar surfaces. Futhermore, notches 515 and 525 are configured so that each smoking article is held rigidly in place along four contact points between members 510 and 520 and does not "slip" axially or longitudinally while it is being maneuvered from station to station or held in place at a station. Other angles and contoured shapes for notches 515 and 525 may be used.

In a preferred embodiment, the gripping surfaces of notches 515 and 525 are lined with conventional emery paper, for example, 240 grade, or some other mildly abrasive material to increase the friction between smoking article 20 and members 510 and 520 and to minimize slip.

In operation, upon an appropriate instruction from microprocessor 1000, flanges 501 and 502 are translated to an "open" position spaced apart a first distance and hand 500 is maneuvered to position notches 515 and 525 on opposite sides of and in alignment with a selected smoking article 20. Article 20 may be resting on chute 220, reorientation fixture 900, or on any one of the measuring insert ents having a suitable receptacle. The first distance is large enough to straddle the largest circumference smoking article in the preselected range of circumferences.

Next, microprocessor 1000 instructs robot 503 to "close" flanges 501 and 502 so that member 510 and support member 560 are translated together and spaced a second distance apart and notches 515 and 525 are in gripping contact with the smoking article. Preferably, member 510 and support 560 are maintained in a parallel orientation. The second distance and the dimensions and depth of notches 515 and 525 are selected so that in the closed position, notches 515 and 525 will grip securely without deformation the smallest and largest dimensioned smoking articles in the preselected range of articles.

In accordance with the preferred embodiment, spring 540 biases lever 530 against stop 550 so that member 520 is urged parallel to member 510. Thus, for the smallest dimensioned article in a selected range, members 510 and 520 are configured and spaced to grip securely the article in notches 515 and 525 whereby member 520 does not significantly move relative to support 560. For larger dimensioned articles in the selected range, the larger dimension will move member 520 to pivot away from member 510 and compress spring 540. Spring 540 will continue to bias member 520 toward member 510 to group securely article 20, even though the second distance is such that the larger dimensioned article would have been crushed in notches 515 and 525 had member 520 not pivoted relative to support 560. In this manner, spring 540 alters or adjusts the force exerted on article 20 so that article 20 is not crushed.

Advantageously, force altering means 570, and in the preferred embodiment spring 540, permits members 510 and 520 to grip securely a wider variation of smoking article dimensions, specifically circumferences, than would be possible by members 510 and 520 that did not have a force altering means. These improvements in gripping range and performance are important for use in a robotic automated test station where different dimensions present substantial problems, in contrast to a manually conducted system where the operator can intuitively adjust his or her grip to the dimension of the article. In this regard, a plurality of smoking articles to be tested do not inherently have identical physical characteristics. For example, there may be a variation in smoking article circumference from article to article in the same sample set or from one group of article to another. In addition, multiple sample sets may have differently dimensioned like articles. A gripping mechanism for a robotic device in accordance with the present invention is thus able to accommodate the desired variations in dimensions so that the resulting testing data of multiple sets is automatic, reliable, and reproducible without an attendant or need to adjust or change the opposing gripping members.

A pair of gripping members 510 and 520 has been constructed and operated successfully for grasping smoking articles having a circumference dimension selected in the range of from 22 to 25 mm. Referring to FIGS. 15-18, members 510 and 520 were constructed with mirror image tip portions each having a width d of about 14mm (0.56 inches) and a thickness t of about 7mm (0.28 inches). Notches 515 and 525 each has two planar sides cut at 45° angles to the surface, thereby forming an angle α of 90°, the vertex of which extends a depth h of about 4.37mm (0.172 inches) relative to member surfaces 511 and 512. The notch base of depth h is located a distance r of about 7mm (0.280 inches) from the tip of the member, and the opening of the notch has a space s of about 8. 76mm (0 345 inches). The distance between surfaces 511 and 521 was fixed at about 2. 0mm, which was obtained by manually filing down a shim plate (not shown) to bring faces 511 and 521 sufficiently close together to obtain a good secure grip on the smallest dimensioned article to be processed, e.g. 22mm in circumference, without deflecting members 510 and 520.

Member 520 is configured so that the base of notch 525 is spaced about 30mm (1.22 inches) from the axis of pin 563. The spring force of spring 540 is selected to be a few tens of grams (a few ounces), preferably 80 to 170g (three to six ounces). Of course ,the optimum spring force for a given gripper design will be selected based upon the particular geometric distances employed in the design of lever 530, member 520, notches 525 and 515, the spacing between member 510 and 520, the range of motion of the hinge of member 520, and the selected range of differently dimensioned smoking articles to be tested. The magnitude of the spring force will depend in part on the distance of separation between pivot pin 563 and notches 525 and 515 and the distance of separation between pivot pin 563 and spring 540.

In accordance with the invention, other types of opposing gripper members may be used, for example, a member which translates, as opposed to rotates, relative to a support, in combination with a force altering means which allows the member to move relative to the support. Furthermore, the force altering means can

have non-linear characteristics in contrast to the typically linear characteristics of a conventional spring.

Advantageously, robot 503, in accordance with the present invention, provides for an economical and efficient gripping of a variety of conventionally sized smoking articles having a circumference in a preselected range of circumference dimensions, including cigarettes, for efficient manipulation of such articles through a programmed sequence of movements and operations without having to change or adjust manually the robotic gripping elements for differently dimensioned articles in the range.

Referring to FIGS. 1, 2, and 5, one embodiment of length station 200 for measuring the length of an article in accordance with the present invention includes chute 220, camera 230 and bracket 240. Chute 220 is configured to receive one article 20 at top 221 of chute 220, and is provided with a grooved surface having a U-shaped cross sectional shape (see FIG. 5) so that article 20 will advance along chute to stop 222 under gravity. Such a surface also may be concave or V-shaped and may be coated with a low friction material, e.g., Teflon™, or highly polished to minimize friction between article 20 and chute 220. Chute 220 also may comprise two rods or rails that are spaced-apart in parallel (not shown) so that articles 20 will proceed along chute 220 and any tobacco or other particles that come loose from articles 20 do not accumulate in chute 220 or otherwise impede the advance of articles 20.

Camera 230 is mounted on bracket 240 to be positioned a selected distance from chute 220. Camera 230 is preferably an electronic linear array camera for measuring lengths along one axis or dimension. Accordingly, that measuring axis is oriented in parallel with chute 220 so that article 20 will be in the proper orientation for obtaining the length measure. Camera 230 is located a focal distance f from the location article 20 will be at when it is measured, and is provided with a field of view r corresponding to focal distance f.

The measurement may be obtained directly by measuring article length L within the field of view r (see FIG. 6) or more preferably indirectly, by measuring the length a of article 20 that extends into the field of view from one edge of the field of view in the first axis (see FIG. 7). In the indirect mode, one edge of field of view r is located a known distance d from stop 222. Thus, camera 230 obtains the measure 1 of article 20 indirectly by summing the measured length a and the known distance d.

In accordance with a preferred embodiment, camera 230 is configured so that distance d is 75 mm, field of view r is 50 mm, one end of which is spaced 75 mm from stop 222, the other end of which extends to 125 mm from stop 222, providing for a focal distance f selectable in the range of from 225 to 260 mm. Thus, camera 230 is capable of measuring automatically conventional cigarettes having a length from 75 to 125 mm. In embodiments where the image appearing in field of view r of camera 230 is not a true measure, the measure must be converted by the magnification (or reduction) power of the camera lens to obtain the true length dimension.

In an alternate embodiment, stop 222 may be provided with a contact switch (not shown) that produces directly or through microprocessor 1000 an enabling signal to camera 230 when article 20 comes to rest against stop 222. In this embodiment, camera 230 will obtain the length measurement in response to the enabling signal.

Camera 230 is preferably a model HVS 256 camera sold by the Microswitch Division of Honeywell, Engelwood, Colorado and has a resolution of 256 pixels in a selected linear dimension or axis. Model HVS 256 is preferably configured to obtain a 50 mm field of view at an accuracy of better than 0.1 mm, preferably 0.05 mm, corresponding to a resolution of better than 0.1 mm, preferably 0.02mm. It is a relatively inexpensive linear array camera, and is thus advantageous to use to measure indirectly the article length.

In making indirect measurements, the first distance d the field of view r and the desired resolution may be adjusted to measure a desired range of acceptable lengths (and variations in lengths) of a large number of different smoking articles.

Also, camera 230 may be moved outwardly and refocused or a different lens used to have a correspondingly increased field of view, or the distance d may be changed as may be appropriate. Other linear array cameras having more pixels, e.g., an EG&G Reticon camera, model LC0120, having 4096 pixels and a resolution of 0.01 mm in one axis, or fewer pixels with a corresponding lower resolution could be used to obtain directly or indirectly the length measurement. Typically linear array cameras having such a higher pixel resolution are, however, substantially more expensive.

Electronic linear array cameras provide almost an instantaneous measure of indirect length a or direct length l depending on the desired configuration. Accordingly, continuous motion length measures are possible. Measures taken while the article is stationary for a period of 0.085 seconds are, however, preferred for optimum resolution.

Camera 230 is preferably adapted to transmit electronically the measured length to microprocessor 1000, which may in turn transmit the data to host computer 1200 for recording and tabulating the data for each article 20 measured.

Subsequent to the length measurement, robot 503 grips article 20 between members 510 and 520 at a distance that is about 65 mm from the filter end for maneuvering article 20 off chute 220 to the selected one

or more workstations for subsequent measurements or tests of the characteristics of the smoking article. Accordingly, chute 220 and stop 222 are suitably located within the range of motion of robot 503 with adequate clearance relating to robot hand 500.

Referring to FIGS. 22-24, fixture 900 for reorienting a smoking article is located on table 12 at a position within reach of robot 503. Fixture 900 provides a location into which an article 20 (shown in phantom lines in FIG. 22) can be deposited by robot 503 so that robot 503 can change its grip on article 20 to a different location. Fixture 900 includes a v shaped, concave surface 910 having a length and two planar surfaces intersecting at an angle B of 110 degrees. Surface 910 is spaced from a stop 920 a distance D2 of about 31.7mm (1.25 inches) to allow members 510 and 520 of robot 503 to grip article 20 without contacting fixture 900. Stop 920 is preferably oriented perpendicular to surface 910 and includes a protrusion 925 which extends from stop 920 so that the end of article 20 is spaced a short distance from stop 920. Surface 910 is preferably at an angle of about 30 degrees relative to table 12 (horizontal) so that article 20 will slide down surface 910 and rest against protrusion 925 of stop 920.

Referring to FIGS. 1, 8, and 9, severing station 300 for severing an article component from the article, more particularly filter rod portion 450 of the article, includes a cutting element 310, aperture 330, air cylinder 340, and ball slide unit 370. Cutting element 310 is used to pass through to sever one smoking article 20 after it is positioned at a selected location in aperture 330 by members 510 and 520 of robot 503. Cutting element 310 is mounted on carriage 360 of ball slide unit 370 between opposing carriage bracket 361 and clamp plate 362. Carriage 360 is mounted on two slide bars 368 and 369, which are mounted in two end blocks 371 and 372 that are respectively supported by spanner bars 373 and 374. Spanner bars 373 and 374 are in turn supported by front side plate 364 and rear side plate 375. Ball slide unit 370 provides a straight, one-dimensional cutting path along which element 310 will travel and may be, for example, model no. DS3-2-C, manufactured by Stelron. The stroke length of air cylinder 340 thus defines the maximum stroke length for element 310, for example, 2.54 cm.

Movement of element 310 is controlled by air cylinder 340 which actuates piston rod 350 to move carriage 360 and carriage bracket 361 in a lateral direction along slide bars 368 and 369. Piston rod 350 is attached to carriage bracket 361 by cylinder block 379. Piston rod 350 is connected to air cylinder 340 and is moved back and forth by air cylinder 340. Air cylinder 340 is preferably a single action device in that a force is applied to extend piston 350 and a spring (not shown) returns piston 350 to its rest position following a lowering of the force. For example, a pressure of 300 kPa (40 psi) of compressed air, applied to compressed air inlet 381 of air cylinder 340, may be used to extend piston 350 to drive carriage 360 so that cutting element 310 passes through smoking article 20. Air cylinder 340 is preferably part no. FOS-04-1.000-3 (Flat 1 air cylinder-single acting-spring return-19mm (3/4 inch) bore-25mm (1 inch stroke)) manufactured and available from Bimba. Air inlet 381 of the cylinder is preferably model no. 11752-1 (hose fitting-#10-32 to 3.2 mm (1/8 inch) I.D. hose) manufactured by Clippard.

Air cylinder 340 is supported by end plate 383 which is also used to separate front side plate 364 from rear side plate 375 and to give overall stability to the cutting unit. Further stability to the cutting unit is provided by support angles 377 and 378 attached to front side plate 364 and rear side plate 375 and table 12.

In one embodiment of the present invention, a solenoid (not shown in the Figures) is used to control delivery of compressed air to inlet 381 to initiate the cutting process. The solenoid is preferably actuated by microprocessor 1000 in response to article 20 being placed in the selected second location. The solenoid also can be controlled manually by a switch mounted in the vicinity of the cutting apparatus.

Alternate devices for moving cutting element 310 in response to article 20 being placed in the second position include stepper motors, linear actuators, rack and pinion mechanisms and similar devices.

Cutting element 310 is preferably a sharp blade, more preferably a conventional single-edged razor blade having a blade length of 3.88 cm. Blade 310 is mounted to carriage 360 between opposing carriage bracket 361 and clamp plate 362. The razor-blade side of clamp plate 362 includes recess 363 which is configured to hold razor blade 310 in the recess at a fixed angle relative to the piston direction. The angle must be sufficient so that the blade severs the smoking article (as contrasted to crushing the article) and passes completely through the cross section of article 20, e.g., 25 to 35 degrees used, more preferably 30 degrees. Additionally, roll pin 366 maybe used to keep razor blade 310 in place during the cutting motion.

In accordance with a preferred use of the present invention, prior to the severing operation, article 20 is preferably placed in orientation station 900 by robot 503. This permits robot 503 to grip article 20 at the mouth end of filter portion 450 between opposing members 510 and 520 and maneuver article 20 axially into aperture 330 extending through front side plate 364 and blade guard 365 to a selected distance or depth. The diameter of aperture 330 is preferably larger than the circumference of the article to be cut to provide tolerance for inserting and extracting articles 20 having a range of circumferences. In a preferred embodiment, the diameter of aperture 330 is 8. 33 mm (0.328 inches), or cigarettes having a circumference in the range of 22-25 mm. Aper-

ture 330 can be modified to accommodate smoking articles of other diameters or cross-sectional shapes by replacing front side plate 364 and blade guard 365 with a front side plate and blade guard having an aperture of appropriate dimensions. Preferably, aperture 330 also includes countersink 367 in blade guard 365 to assist in the initial guiding of article 330 into the cutting position.

During the cutting operation, robot 503 holds article 20 by its filter end portion 450 with the portion of the article to be severed in the cutting path of blade 310. Once in the second location, air cylinder 340 is actuated to move razor blade 310 to sever article 20 at the designated portion.

Microprocessor 1000 positions robot 503 in response to the previously identified length of the article segment to be severed, e.g., filter portion 450 of a cigarette. Thus, robot 503 is programmed to move members 510 and 520 to grip article 320 at, for example, at the mouth end or at midpoint of the filter segment 450, and to insert article 320 to a depth so that razor blade 310 will sever article 320 at a location that is a selected distance from the end of the filter segment to be severed. The selected distance is preferably 2 mm. For example, for a smoking article having a nominal filter length of 27 mm, the robot may be programmed to cut the smoking article at a distance of 29 mm from the mouth end of the filter. Thus, the razor blade will cut through the tobacco and not the filter material.

Advantageously, in accordance with the present invention, severing station 300 provides for severing a filter rod portion from a smoking article so that the automatic test station can perform characterization tests both on the complete article and its filter (or other) component. The precision and accuracy of the cutting operation is determined by the precision and accuracy of the mechanical parts of the computer controlled apparatus as contrasted to an operator's manual ability. The quality of the cut also has been made more reproducible, thereby enhancing statistical analysis and accuracy of tests performed on a plurality of like components severed from a plurality of like smoking articles.

Referring to FIGS. 1, and 10-12, deshredding station 400 for removing tobacco shreds from the severed component includes housing 400, deshredder motor 410, deshredder tool 420, vacuum port 430, and air stream conduit 440. Housing 400 has a motor end 402 and an aperture end 404. Deshredder motor 410, which is mounted in end 402 of housing 400, is used to rotate deshredder tool 420 at a selected speed in the range of 3000 to 4000 rpm, preferably 3600 rpm. Robot 503 inserts filter portion 450 (shown in cross section) in end 404 of housing 400 in axial alignment with motor 410 and tool 420. End 404 has an aperture for receiving filter portion 450. The aperture dimension is preferably selected to receive smoking article filter portions having a circumference in a range of circumferences, e.g., 22-25 mm, and to permit annular air flow into housing 400 when filter portion 450 is inserted. Preferred aperture dimensions are 9 to 10 mm in diameter.

Presenting end 452 of portion 450 is preferably brought within a preselected distance, e.g., 2 mm, of the tip of deshredder tool 420. A stream of high pressure air from source 442 is blown onto presenting end 452 of filter 450 through conduit 440. Rotating deshredder tool 420 may contact the tobacco shreds attached to filter 450 that are not loosened by the stream of air, to loosen those shreds not removed by the air stream. Preferably, vacuum port 430 also is provided to exhaust out through a flow path to vacuum 433 any loosened tobacco shreds that have become detached from the end of the filter by the air stream, deshredder tool 420 or both.

Deshredder motor 410 is held in housing 400 by way of screws 412. Attached to the end of the deshredder motor shaft 414 is deshredder tool 420, which is held in place by way of set screw 413. Deshredder tool 420 can be made of a hard material, but most preferably it is made out of a hard steel or aluminum alloy, for example, having a black oxide finish.

Referring to FIGS. 11 and 12, tool 120 preferably has two prongs 422 and 423 extending from tip 421 such that tip 421 has a rectangular cross section of width w and length d. Length d corresponds to the diameter in which tip 421 rotates (which is less than the corresponding diameter of the filter portion), for example, in the range of 5 to 5.9mm (0.2 to 0.23 inches), preferably 5mm (0.2 inches). Each prong 424 and 423 preferably is a four sided structure of first dimension w, preferably about 1.1mm (0.045 inches), and second dimension t, preferably about 1.3mm (0.053 inches), such that each prong projects a distance h, preferably about 3.8mm (0.15 inches), from the unmilled rectangular body of tip 421 of tool 420. Prongs 422 and 423 are preferably located at the periphery of distance d, separated by space s of about 2.4mm (0.095 inches).

In accordance with an alternate embodiment, deshredder tool 420 may have an alternate motion, for example, a circular back-and-forth motion where the tool rotates half of a revolution before it reverses direction. Tool 420 also may have an alternate tip configuration, for example, more than two prongs, prongs at angles relative to one another, a hook, a scythe, a flat loop, or a spiral or helical section.

Conduit 440, which is preferably simply formed of standard 3.2mm (1/8 inch) outer diameter copper tubing having an inner diameter of 2mm (0.07 inch) terminates adjacent deshredder tool 420. Such tubing is malleable and conduit 440 can be bent, as necessary, to place tip 444 in close proximity to the selected location and deshredder tool 420, directed at presenting end 452 of filler 450. Tip 444 is preferably formed by cutting tube 440 transversely, but may also be provided with a configured shape to provide a nozzle. Source 442 is connected

to conduit 440 and provides an air stream, preferably a high pressure air stream in the range of 70 to 300 kPa (10 to 40 psi), more preferably 150 kPa (20 psi). Source 442 preferably has an on condition and an off condition for regulating air flow depending upon whether or not a filter portion is in position or being brought into position to be deshredded. In accordance with the invention, other types of inert high-pressure gas, for example, nitrogen, and other types of gas jet delivery systems could be used.

Vacuum source 433 is attached to vacuum port 430 of housing 400 by conduit 432. Vacuum source 433 is preferably a 13mm (1/2 inch) diameter house vacuum and has a suction in the range of 380 to 640mm (15 to 25 in.)-Hg, sufficient to exhaust all of the gas provided through conduit 400 and maintain a nominal or slight negative pressure inside housing 400. Vacuum source 433 serves to entrain and to exhaust tobacco shreds which become detached from filter 150 and has an on condition and an off condition depending upon whether or not a filter portion is in position or being brought into position to be deshredded.

In operation, severed filter portion 450 is gripped between opposing members 510 and 520 of robot 503 at a first location, preferably the same position used for the severing operation, and is maneuvered axially into end 404 of housing 400. Robot 503 is provided with information specifying the length of the filter and positions filter 450 to a predetermined selected location corresponding to placing presenting tobacco end 452 of the filter 450 into the deshredding area. In one embodiment, microprocessor 1000 issues an instruction to activate each of deshredder motor 410 to cause tool 420 to rotate, air source 442 to commence air flow through conduit 440, and vacuum source 443 to commence exhausting air through port 430 during or prior to insertion. Thus, these elements are fully operative when filter 450 is positioned in the selected location. As robot 503 brings the end of filter 450 to within a few mm of deshredder tool 420, for example, 1.5 to 2.5 mm, more preferably 2 mm, presenting end 452 becomes subjected to the gas flow which will begin to loosen and remove tobacco shreds even before end 452 is at the selected location.

Robot 503 then holds filter 450 in the selected position for a period of 1 to 4 seconds, more preferably 2 seconds. At the end of this period, microprocessor 1000 issues instructions to deactivate deshredder motor 410, air source 442, and vacuum 433, and to remove the deshredded filter 450 from the deshredder housing 400. In an alternate embodiment, tool 420, source 442 and vacuum 433 may be continuously operating.

Depending on the amount of tobacco shreds to be removed, in the selected location tool 420 may be initially immersed in a relatively thick plug of tobacco shreds thereby to loosen the shreds, or may not be in contact with any shreds. The distance between the tip of tool 420 and the end of filter 450 is selected so that if the tool does not contact any shreds in area 452, the air flow has either removed them or is sufficient to remove them during the time period the filter is maintained at the selected location, and there is an insufficient force to retain the shreds on the filter end to withstand both the air flow and tool 420. In operation, it has been found that the air stream removes most of the tobacco and that the tool is most useful when the presenting portion contains a length of cigarette paper enclosing a plug of tobacco shreds in excess of 2 mm thick. Thus, using deshredding tool 420 to remove all but the last 2 mm of shreds provides for the air stream to remove the remaining shreds and complete the deshredding operation. In addition, deshredding tool 420 may provide a turbulent air stream that facilitates loosening the shreds.

In accordance with the present invention, a plurality of measuring instruments are provided as stations to perform characterization tests on one or more groups of like articles 20 or components, specifically filter portions 450, of articles 20.

Circumference station 600 measures the circumference of one article 20 at a time. Station 600 is mounted at a fixed position on table 12 within the reach of robot 503. Station 600 is preferably a commercial device, model Filtrona Lasermike FLM 200, available from Fidus Insert ent Corporation, Richmond Virginia. The commercial device was modified for use with the present invention by enlarging the sample holder portion to facilitate insertion and extraction of article 20 by robot 503. In accordance with the present invention, robot 503 grips article 20 and maneuvers to insert article 20 axially into the sample holder to a selected depth based on the previously encoded nominal length of article 20 (not shown), whereupon microprocessor 1000 sends a command to device 600 instructing device 600 to read the circumference. Article 20 is then rotated through one revolution as conventional laser measuring techniques are used to take 200 measurements of the diameter of article 20. Device 600 then calculates the circumference of article 20 from the average of the diameter measurements. This data is communicated to microprocessor 1000 and stored, optionally in host computer 1200, for subsequent tabulation and analysis. Following the conclusion of the measurement, robot 503 extracts article 20 from the sample holder and advances it to the next station, in accordance with the program for processing that particular article 20.

PDI station 700 measures the pressure drop and filter ventilation of one article 20 at a time. Station 700 is secured at a fixed location on table 12 within the reach of robot 503. Station 700 is preferably a commercial device, model PDI/ODI available from Fidus Corporation, Richmond Virginia. The commercial device is normally manually operated. For use with the present invention, the device was modified to install conventionally

a suitable number of solenoids and relays so that microprocessor 1000 could control the "manual" operation of the instrument. Thus, to operate the instrument, microprocessor 1000 issues appropriate instructions first to robot 503 to manipulate one article 20 and to insert or release article 20 into the commercial receiving portion of the instrument, and, second, to actuate the relays to drive the solenoids thereby to conduct normally the pressure drop and ventilation measurement procedures.

Similarly, microprocessor 1000 is connected to the data port of the instrument so that the measurements obtained are communicated to microprocessor 1000 for recordation and tabulation. Following the measurement procedures, microprocessor 1000 controls the instrument to eject the article 20 to the receiving portion, whereupon robot 503 is instructed to grip again article 20 and maneuver it to the next station, in accordance with the program for processing that particular article 20.

PDI station 800 measures the filter pressure drop of one filter rod portion 450 at a time. Station 800 is secured at a fixed location on table 12 within the reach of robot 503. Station 800 is preferably a commercial device, model PDI available from Fidus Corporation, Richmond Virginia. The commercial device is normally manually operated. For use with the present invention, the device was modified to install a suitable number of solenoids and relays in a conventional manner so that microprocessor 1000 could control the "manual" operation of the instrument. Thus, to operate the instrument, microprocessor 1000 issues appropriate instructions first to robot 503 to manipulate filter rod portion 450 and to release or insert filter 450 into the commercial receiving portion of the instrument, and, second, to actuate the relays to drive the solenoids thereby to conduct normally the filter pressure drop measurement. Similarly, microprocessor 1000 is connected to the data port of the instrument so that the measurement obtained is communicated to microprocessor 1000 for recordation and tabulation. Following the measurement procedure, microprocessor 1000 controls the insert ent to eject the filter portion 450 to a trash receptacle.

Station 850 measures the filter length of a filter rod portion 450 one at a time. Station 850 is secured at a fixed location on table 12 within the reach of robot 503. Station 850 is preferably a commercial device, model EG-250 available from Ono Sokki Co., Ltd., Tokyo Japan. The commercial device is a digital linear gauge for measuring thicknesses between a movable tip and a fixed base (not shown) having a data communications port for providing measured data and is normally manually operated. For use with the present invention, the device was modified to install an air cylinder and a solenoid in a conventional manner so that microprocessor 1000 could control the "manual" operation of the instrument, specifically the movement of the tip relative to the base. Thus, to operate the insert ent, microprocessor 1000 issues appropriate instructions to robot 503 to manipulate filter rod portion 450 in axial alignment between the tip and the base of the commercial receiving portion of the instrument, and to the solenoid and air cylinder to move the tip to engage the aligned filter portion to conduct the filter length measurement and then to release the filter. Similarly, microprocessor 1000 is connected to the data port of the instrument so that the measurement obtained is communicated to microprocessor 1000 for recordation and tabulation. Following the measurement, microprocessor 1000 instructs robot 503 to grip filter 450, then controls the solenoid and air cylinder and the tip is retracted from the base so that filter portion 450 is removed by robot 503 and maneuvered to the next station, in accordance with the program for processing that particular filter portion 450.

The data collected by microprocessor 1000 are typically transferred to a controller or host computer 1200 for processing. Computer 1200, includes a PC/286 microprocessor device, a model SUN SPARCstation available from Sun Microsystems, Inc. and a conventional database computer. An Ethernet network (not shown) links microprocessor 1000, computer 1200 and the various test instruments for communications therebetween.

Referring to FIG. 1, barcode reader 1300 is connected to computer 1200 for entering sample identification codes for each sample set of a plurality of like articles 20 and creating a database file of the pertinent data regarding the nominal dimensions and characteristics of the articles in that sample. The sample set is inserted into a designated hopper 110 of hopper feeder 100 which is correlated to the bar code given. Database files are shared by computer 1200 and microprocessor 1000 and stored on a software disk that is accessible over the Ethernet network.

Test station 10 in accordance with the present embodiment can test filtered or non-filtered cigarettes and other types of smoking articles having circumferences in the range of 22 to 25 mm and nominal lengths of 80 to 120 mm. Use of the hopper feeder device 100 provides a plurality of hoppers 110, e.g., eighteen, to be filled, each hopper 110 holding up to 30 cigarettes in a given sample set. In the preferred embodiment, test station 10 can be programmed to measure any of article pressure drop, filter ventilation, filter pressure drop, circumference, cigarette length, and filter length on any number of plurality of articles in each sample set in any sequence, provided that tests on a complete article are completed before tests are conducted on a component severed from that article.

Operation of test station 10 in accordance with the present invention begins when the operator loads a sample set into hopper feeder 100, provides the sample set with an identifying bar code, and creates a test

sequence database file for that set in one of host computer 1200 or microprocessor 1000. The database file typically includes the number of articles 20 in the sample set, the nominal length of the articles and their filter portions and other pertinent dimensions of the articles or their components and the test protocol for that sample set, i.e., which tests are to be performed on how many of the articles in that sample set This information is then logged in microprocessor 1000 or computer 1200 by the operator at operator workstation 1100 as each sample set is deposited into a designated hopper 110.

The operator can continue loading the system with up to eighteen samples, each sample having a bar code and an associated database. For example, a typical sample set will have twenty-five articles. The operator may instruct that each article will be measured for article length, circumference, and pressure drop, and for filter ventilation, pressure drop, and length. Alternately, the operator may instruct that only ten of the twenty-five articles will be measured for article length and circumference and filter length, and all twenty-five of the articles will be measured for article pressure drop, filter ventilation, and filter pressure drop. In this regard, robot 503 will not maneuver the other fifteen articles to those stations not selected.

In an alternate embodiment, with appropriate software and memory capacity, it may be possible for the operator program station 10 with a particular order for testing the articles in each sample set, such that the selected ten tests for article length will be taken off the first five articles and the last five articles, whereas the ten tests for filter length will be taken off alternating filter rod portions. Other combinations thus could be created as desired.

Preferably, computer 1200 is used to write the selected barcodes into a "worklist" file that will be used by microprocessor 1000. After entry of the last test specification, the operator moves to microprocessor 1000 and answers software generated questions which define the station's operating mode. Microprocessor 1000 initializes robot 503 and verifies that the communications network is operational. It then waits for the operator to enter the command at operator workstation 1100 to actually start sample testing. After entering this start command, the operator is then free to perform other tasks.

Microprocessor 1000 transfers the barcode worklist and database specification files from computer 1200 data disk, reads the first barcode from the worklist, extracts the selected test requirements from the corresponding specification file and displays this information on a monitor (e.g., at operator workstation 1100) for operator observation.

A sample of cigarettes from hopper 110 is fed into feeding device 140. The first cigarette is fed from device 140 onto and down chute 220 so that it comes to rest against stop 222 with filter end 450 down, where its length is measured by camera 230. Robot 503 picks up the cigarette by the tobacco end at a distance of about 65 mm from the filter end, rotates it to a filter end up position and sequences it through, for example, station 700 which obtains the article pressure drop and ventilation measurement and station 600 which obtains the article circumference measurement as called for in the specification file. Microprocessor 1000 operates each instrument, reads and records the data, and displays the test values on the system monitor. If no further tests are to be conducted, robot 503 may move article 20 to a waste receptacle.

For conducting subsequent tests on filter portion 450, robot 503 retrieves article 20 from the last smoking article test station and places and releases article 20 in reorientation fixture 900. Robot 503 then moves hand 500 to rotate and grip article 20 by the filter end. The cigarette is placed in the severing station 300 and filter 450 is cut approximately two mm longer than the nominal length obtained from the specification file. The sheared tobacco rod drops through a chute and into a trash receptacle (not shown). Robot 503 then takes filter 450 to deshredding station 400, where any remaining tobacco is dislodged and vacuumed into a holding tank.

Robot 503 then sequences the filter 450 through stations 850 and 800 for measuring the filter length and filter pressure drop (or vice versa) as indicated in the specification file. The filter pressure drop test is preferably conducted last. Accordingly, following the measurement, a blast of air blows filter 450 out of the instrument, into a chute which leads to a trash receptacle (not shown). Test station microprocessor 1000 operates each instrument, collects and records the data and displays the data obtained from these instruments on the system monitor.

After all cigarettes in the sample set have been tested, the accumulated data are transmitted in a test data file to host computer 1200. It has been found that it requires approximately thirty minutes to run a sample of 25 cigarettes through the full compliment of tests.

The next sample set in the following hopper 110 is then unloaded into device 140, the bar code and corresponding database file of parameters obtained, and the specified test sequence for the samples in that set is run. This procedure is repeated until the last sample set has been tested. When the data for the final sample set in the worklist have been transmitted, microprocessor 1000 searches host computer 1200 for another worklist. Additional sample sets can be loaded into hopper feeder 110 and a second worklist containing barcodes having corresponding databases can be created in host computer 1200. If such a second worklist is found, it is transferred to microprocessor 1000 and the testing continues; otherwise, robot 503 is moved to its rest posi-

tion.

The test station of the present invention has a flexible design for optimal use. If host computer 1200 fails, the necessary coding and parameter entry can be entered directly into microprocessor 1000. The data are stored in microprocessor 1000 and sent to the host computer 1200 when communications have been restored. If hopper feeder 100 is not functional, sample sets can be loaded by hand into feeder mechanism 140.

The operator also can bypass a faulty instrument by not requesting a specific test in the test specification file of the database. The operator also may use the test instruments manually, for example, if the robot is not operational or only a select few tests are required. This may be accomplished by inserting a cigarette into an instrument, manually activating the insert ent to conduct the test, and instructing microprocessor 1000 when to read the data obtained by the instrument. The data are typically saved in microprocessor 1000 and sent to host computer 1200 when the testing is completed.

Test station 10 also looks for operational problems while it is running, such as a cigarette not feeding from the hopper, an insert ent blocked by a previously tested cigarette/filter, or a cigarette not being properly placed into an insert ent. When one of these situations is detected, test station 10 tries to correct the problem. The station operating mode specified by the operator determines how test station 10 reacts if it is unable to correct the problem.

When microprocessor 1000 is operating in a mode having an operator in the area and it is unable to correct automatically a problem, it signals the operator that a problem has occured, stops robot 503 and requests the operator to correct the problem and restart the operation. When restarted, operation resumes where the problem was detected.

When operating in an unattended mode and microprocessor 1000 is unable to correct the problem, it bypasses the problem instrument and goes to the next instrument in the test sequence. Microprocessor 1000 also loads an appropriate failure message into a log file which is transmitted to host computer 1200 along with the test data. This file may be used later to determine what caused the problem.

EXAMPLE

A test station in accordance with the preferred embodiment described above was constructed using the instruments described above. Its operation was compared to a manually operated test station using the same type of instruments.

Three different brands, whose lengths range from 84 to 120 mm, were tested for comparison of data acquired by the robotic test station of the present invention aid by the manual procedure using the conventional instruments. Two sets of samples were taken from the same population of cigarettes; one set was run on the robotic test station and the second set was run on manually operated insert ents. Comparisons were made for cigarette length and circumference, total pressure drop, filter ventilation, filter length and filter pressure drop. The results, which are set forth in Tables I-VI, show that the differences between the robotic test station and the manually operated instruments are less than the standard deviations of the methods.

TABLE I

Total Pressure Drop, mm of H_2O

Brand		Robot	Manual	Difference, Δ
Sample A	$\bar{x}$	126.2	127.0	0.8
	σ	6.2	7.6	
Sample B	$\bar{x}$	120.2	120.4	0.2
	σ	4.7	4.3	
Sample C	$\bar{x}$	133.9	135.7	1.8
	σ	4.7	6.3	

TABLE II

Filter Pressure Drop, mm of H_2O

Brand		Robot	Manual	Difference, Δ
Sample A	$\bar{x}$	68.9	68.8	0.1
	σ	2.9	3.3	
Sample B	$\bar{x}$	99.0	100.5	1.5
	σ	5.1	4.2	
Sample C	$\bar{x}$	103.0	100.9	2.1
	σ	5.1	4.5	

TABLE III

Filter Length, mm

Brand		Robot	Manual	Difference, Δ
Sample A	$\bar{x}$	26.54	26.83	0.29
	σ	0.12	0.21	
Sample B	$\bar{x}$	26.74	26.68	0.06
	σ	0.14	0.18	
Sample C	$\bar{x}$	31.25	31.38	0.13
	σ	0.32	0.28	

TABLE IV

Circumference, mm

Brand		Robot	Manual	Difference, Δ
Sample A	$\bar{x}$	24.78	24.91	0.13
	σ	0.10	0.09	
Sample B	$\bar{x}$	24.95	24.89	0.06
	σ	0.10	0.09	
Sample C	$\bar{x}$	23.12	23.11	0.01
	σ	0.04	0.09	

TABLE V

Cigarette Length, mm

Brand		Robot	Manual	Difference, Δ
Sample A	$\bar{x}$	99.05	98.89	0.16
	σ	0.21	0.54	
Sample B	$\bar{x}$	83.92	83.89	0.03
	σ	0.22	0.27	
Sample C	$\bar{x}$	119.64	119.59	0.05
	σ	0.18	0.19	

TABLE VI

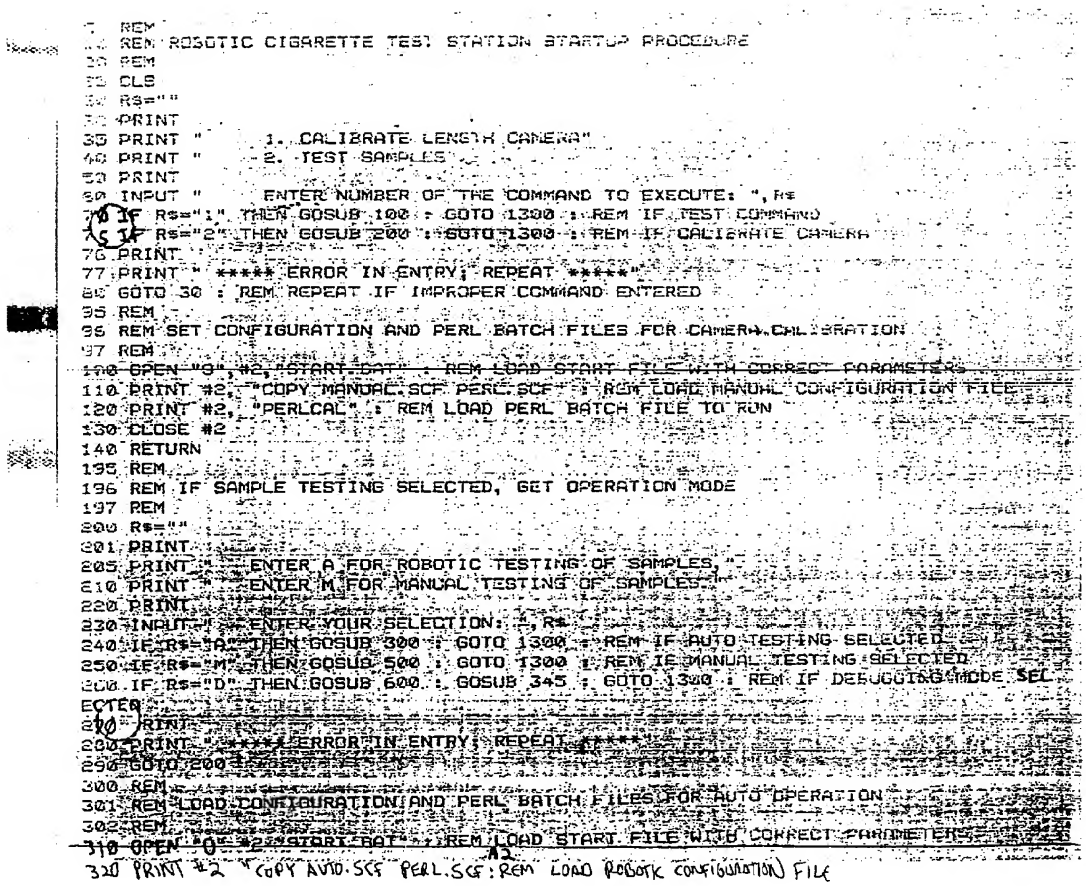
Ventilation, %

Brand		Robot	Manual	Difference, Δ
Sample A	$\bar{x}$	0.0	0.0	0.0
	σ	0.0	0.0	
Sample B	$\bar{x}$	21.3	22.1	0.8
	σ	2.1	2.3	
Sample C	$\bar{x}$	26.4	26.4	0.0
	σ	1.7	1.9	

Although the robotic test station requires about twice the time to process samples as the manually operated station, it facilitates continuous and consistent handling of cigarettes and filters and is capable of running a full compliment of tests on 36 sample sets of 25 articles per day. It also provides for assured testing of smoking articles and filters from these article, an improved characterization of the samples, and can operate unattended. Improvements in speed could be obtained by selection of a different robot device and spacing of the various test stations.

```
; MAIN BATCH FILE FOR ROBOTIC CIGARETTE TEST STATION
; ACTIVATES A BASIC PROGRAM TO GET OPERATING MODE, THEN
; INVOKES START.BAT, WHICH STARTS THE APPROPRIATE PERL
; ROUTINE. AFTER PERL ROUTINE EXECUTES, TMPXFER IS RUN TO
; TRANSFER ANY FILES FROM THE TEMPORARY DIRECTORY TO G:
; THEN THE BAT FILE LOOPS AROUND AND REPEATS ITSELF.  3/5/90 WBA
;
ECHO OFF
:LOOP
CLS
ECHO WAITING TO START TESTING
PAUSE
BASICA INITPROC
COMMAND /C START
command /c TMPXFER
GOTO LOOP
```

SOFTWARE APPENDIX



```
REM
REM ROBOTIC CIGARETTE TEST STATION STARTUP PROCEDURE
REM
CLS
R$=""
PRINT
PRINT "     1. CALIBRATE LENGTH CAMERA"
PRINT "     2. TEST SAMPLES"
PRINT
INPUT "     ENTER NUMBER OF THE COMMAND TO EXECUTE: ",R$
IF R$="1" THEN GOSUB 100 : GOTO 1300 : REM IF TEST COMMAND
IF R$="2" THEN GOSUB 200 : GOTO 1300 : REM IF CALIBRATE CAMERA
PRINT
PRINT " ***** ERROR IN ENTRY; REPEAT *****"
GOTO 30 : REM REPEAT IF IMPROPER COMMAND ENTERED
REM
REM SET CONFIGURATION AND PERL BATCH FILES FOR CAMERA CALIBRATION
REM
OPEN "O",#2,"START.BAT" : REM LOAD START FILE WITH CORRECT PARAMETERS
PRINT #2, "COPY MANUAL.SCF PERL.SCF" : REM LOAD MANUAL CONFIGURATION FILE
PRINT #2, "PERLCAL" : REM LOAD PERL BATCH FILE TO RUN
CLOSE #2
RETURN
REM
REM IF SAMPLE TESTING SELECTED, GET OPERATION MODE
REM
R$=""
PRINT
PRINT "     ENTER A FOR ROBOTIC TESTING OF SAMPLES,"
PRINT "     ENTER M FOR MANUAL TESTING OF SAMPLES."
PRINT
INPUT " ENTER YOUR SELECTION: ",R$
IF R$="A" THEN GOSUB 300 : GOTO 1300 : REM IF AUTO TESTING SELECTED
IF R$="M" THEN GOSUB 500 : GOTO 1300 : REM IF MANUAL TESTING SELECTED
IF R$="D" THEN GOSUB 600 : GOSUB 345 : GOTO 1300 : REM IF DEBUGGING MODE SELECTED
PRINT
PRINT " ***** ERROR IN ENTRY; REPEAT *****"
GOTO 200
REM
REM LOAD CONFIGURATION AND PERL BATCH FILES FOR AUTO OPERATION
REM
OPEN "O",#2,"START.BAT" : REM LOAD START FILE WITH CORRECT PARAMETERS
PRINT #2, "COPY AUTO.SCF PERL.SCF" : REM LOAD ROBOTIC CONFIGURATION FILE
```

```
330 PRINT #2  "PERLAUTO" : REM LOAD PERL.BATCH FILE TO RUN
340 CLOSE #2
345 R$=""
347 PRINT
350 PRINT "   ENTER R IF TEST PARAMETERS ARE TO BE ENTERED REMOTELY
                AT THE TEST STATION CONSOLE
355 PRINT "
360 PRINT "   ENTER L IF TEST PARAMETERS ARE TO BE ENTERED LOCALLY
                AT THE TEST STATION CONSOLE
365 PRINT
370 PRINT
380 INPUT "   ENTER YOUR CHOICE: ", R$"
390 IF R$="R" THEN GOTO 700 : GOTO    : REM IF REMOTE PARAMETER ENTRY SELECTED
400 IF R$="L" THEN GOTO 800 : GOTO    : REM IF LOCAL PARAMETER ENTRY SELECTED
410 PRINT
420 PRINT " ***** ERROR IN ENTRY; REPEAT *****"
430 GOTO 345 : REM IF ILLEGAL ENTRY, REPEAT
500 REM
501 REM LOAD CONFIGURATION AND PERL BATCH FILES FOR MANUAL OPERATION
502 REM
510 OPEN "O",#2,"START.BAT" : REM LOAD START FILE WITH CORRECT PARAMETERS
520 PRINT #2,  "COPY MANUAL.SCF PERL.SCF" : REM LOAD MANUAL CONFIGURATION FILE
530 PRINT #2; "PERLMAN" : REM LOAD PERL BATCH FILE TO RUN
540 CLOSE #2
550 RETURN
600 REM
601 REM LOAD CONFIGURATION AND PERL BATCH FILES FOR DEBUGGING
602 REM
610 OPEN "O",#2,"START.BAT" : REM LOAD START FILE WITH CORRECT PARAMETERS
620 PRINT #2,  "COPY AUTO.SCF PERL.SCF" : REM LOAD AUTO CONFIGURATION FILE
630 PRINT #2,  "PERL" : REM LOAD PERL BATCH FILE TO RUN
640 CLOSE #2
650 RETURN
700 REM
701 REM   IF REMOTE PARAMETER ENTRY SELECTED
702 REM
710 OPEN "O",#2,"OPMODE" : REM LOAD MODE FILE WITH CORRECT MODE
720 PRINT #2,  "REMOTE"
730 CLOSE #2
740 PRINT
750 PRINT "     *****  ENTER TEST PARAMETERS AT WORKSTATION CONSOLE *****"
760 PRINT "     *****  PLACE SAMPLES IN HOPPER IN THE PROPER ORDER *****"
770 GOTO 840
800 REM
801 REM   IF LOCAL PARAMETER ENTRY SELECTED
802 REM
810 OPEN "O",#2,"OPMODE" : REM LOAD MODE FILE WITH CORRECT MODE
820 PRINT #2,  "LOCAL"
830 CLOSE #2
840 R$=""
845 PRINT
850 PRINT "     BE SURE ROBOT IS IN PROPER POSITION FOR INITIALIZATION.
860 PRINT "     BE SURE INSTRUMENTS ARE IN PROPER STATE FOR START-UP.
870 INPUT "     ENTER R WHEN READY TO RUN : ", R$
880 IF R$="R" THEN GOTO 900 : REM IF READY TO RUN
890 PRINT
895 PRINT " ***** ERROR IN ENTRY; REPEAT *****"
896 GOTO 840 : REM IF ILLEGAL ENTRY, REPEAT
900 RETURN
1000 SYSTEM
1010 END
```

43

PERL.BAT

```
COPY AUTO.SCF PERL.SCF
cls
echo LOADING PERL V16D . . . .
c:perl16d =10000 -p48000 -d32000 -rSTARTPGS
```

PERLCAL.BAT

```
COPY MANUAL.SCF PERL.SCF
cls
echo LOADING PERL V16D . . . .
c:perl16d =10000 -p48000 -d32000 -rCAMCAL
```

PERLAUTO.BAT

```
COPY AUTO.SCF PERL.SCF
cls
echo LOADING PERL V16D . . . .
c:perl16d =10000 -p48000 -d32000 -rSTARTUP
```

PERLMAN.BAT

```
COPY MANUAL.SCF PERL.SCF
cls
echo LOADING PERL V16D . . . .
c:perl16d =10000 -p48000 -d32000 -RMANUAL
```

```
COPY %1.SCF PERL.SCF
cls
echo LOADING PERL V16D . . . .
c:perl16d =10000 -p48000 -d32000 -rSTARTPGS
```

TMPXFER.BAT

```
: THIS PROCEDURE CHECKS FOR FILES IN THE TEMP STORAGE DIRECTORY
: \LINK\WORK\TMP.  IF FILES FOUND THERE, A CHECK IS MADE TO SEE IF
: THE NETWORK IS OPERATIONAL. IF IT IS OPERATIONAL, THE FILES ARE
: TRANSFERED TO G: FOR WORKSTATION USE AND DELETED FROM THE
: \LINK\WORK\TMP DIRECTORY.   1/30/90   WSA
:
rem echo off
if not exist \link\work\tmp\*.dat goto finish
nfsping pm14
if errorlevel 1 goto finish
copy \link\work\tmp\*.dat g:
del \link\work\tmp\*.dat
:finish
```

```
procedure startpos
   use robot
   rem init robot
   speed 5
   nest1
   speed 2
   GRIP7725
end procedure
```

A4

```
PROCEDURE CAMCAL
!  THIS PROCEDURE IS USED TO CALIBRATE THE ROD LENGTH CAMERA.
!  A WAKE-UP MESSAGE IS SENT TO THE CAMERA FIRST.  THEN, IT TURNS ON THE
!  INTERNAL LIGHT, UNTIL THE OPERATOR ENTERS Q ON THE CONSOLE.  THE CAMERA
!  THEN STARTS TAKING MEASUREMENTS, DISPLAYING THEM ON THE SCREEN AND ON
!  THE MANUAL CONTROL STATION DISPLAY.  THIS CONTINUES UNTIL THE OPERATOR
!  AGAIN ENTERS Q ON THE CONSOLE, AFTER WHICH THE PROGRAM EXITS BACK TO DOS
!
  DEFINE CL$ AS CLEN
  CLEAR
  CL$="XMZ" ! SEND WAKE UP MESS TO CIG LEN GAUGE
  SEND CL$
  RECEIVE CL$
  G$=""
  DISPLAY
  DISPLAY "THE CENTER LEDS ON THE CAMERA SHOULD NOW BE LIT."
  DISPLAY "ENTER Q WHEN FINISHED."
  CL$="XDF" ! DISPLAY FOCUS ON LEDS
  SEND CL$
REM  RECEIVE CL$
  G$="."
  WHILE G$<>"Q"
    G$=READKEY$
  END WHILE
  CL$="XDS00" ! SET MESS TO DISPLAY FIELD OF VIEW ON LEDS
  SEND CL$
REM  RECEIVE CL$
  DISPLAY
  DISPLAY "USE ADJUSTMENTS TO CALIBRATE CAMERA, USING SHORT AND LONG RODS."
  DISPLAY "ENTER Q WHEN FINISHED."
  G$=""
  WHILE G$<>"Q" ! WAIT FOR Q TO BE ENTERED
REM GETLEN ! READ AND CALCULATE LENGTH
REM  CL$="XTL9"
REM  SEND CL$
REM  RECEIVE CL$
REM  CL$="T"
REM  SEND CL$
REM  RECEIVE CL$
REM  CLEND$=CL$
     GETLEN
REM  MAN1$="LENGTH = "+CLEND$
REM  DISMANUL ! DISPLAY ON MANUAL PENDANT
     DISPLAY "  ROD LENGTH = ";CLEND$;"  ENTER Q IF FINISHED."
     SET TIMER 1 FOR 2 SECONDS
     WAIT FOR TIMER 1
     G$=READKEY$ ! CHECK KEYBOARD FOR INPUT
  END WHILE
  MAN1$=""
  DISMANUL !CLEAR DISPLAY
  SYSTEM
END PROCEDURE
```

```
PROCEDURE STARTUP
  GRIP7725  ! SET GRIP POS 7,7,25
  CLEAR
  DEFINE CR$ AS CPDI ! CIG RTD PORT
  DEFINE D$ AS DIL ! DILUTION PORT
  DEFINE C$ AS CIRC ! CIRCUMFERENCE PORT
  DEFINE F$ AS FLGAUGE  ! FILTER LENGTH PORT
  DEFINE CL$ AS CLEN  ! CIG LENGTH PORT
  DEFINE FR$ AS FPDI  ! FILTER RTD PORT
  DISPLAY
  CLEAR
  ERRSTOP$="F" ! SET FLAG TO NOT STOP ON ERRORS
  MAIN  ! EXECUTE MAIN LOOP
  OPEN
  NEST1 ! MOVE TO START POSITION
  SYSTEM ! EXIT PERL AFTER SAMPLES TESTED
REM  PRINT " END OF STARTUP PROC ";TIME$
END PROCEDURE
```

A6

```
PROCEDURE MAIN
  REM THIS IS THE MAIN PROCEDURE FOR THE ROBOTIC CIGARETTE TEST STATION.  IT
  REM CHECKS TO SEE IF THE TEST PARAMETERS ARE TO BE ENTERED LOCALLY OR
  REM REMOTELY. IF LOCAL, THE PARAMETER ENTRY PROCEDURE IS EXECUTED. IF IN
  REM REMOTE, THE OPERATION OF THE NETWORK IS CHECKED. IF NOT OPERATIONAL, THE
  REM OPERATOR IS ALLOWED TO ENTER THE LOCAL ENTRY MODE. IF OPERATIONAL, THE
  REM REMOTE DRIVE IS CHECKED FOR THE PRESENCE OF A WORKLIST. IF FOUND, THE
  REM WORKLIST AND THE SPECFILES ARE TRANSFERRED FROM E: AND F: RESPECTIVELY,
  REM TO C:\LINK\SPEC\.   IN EITHER LOCAL OR REMOTE MODE, AFTER THE TEST SPECS
  REM HAVE BEEN FOUND, THE OPERATOR IS PROMPTED TO ENTER R WHEN READY TO START
  REM TESTING. AFTER EACH SAMPLE IS COMPLETED, THE DATA IS TRANSFERED TO
  REM STORAGE. THIS IS REPEATED UNTIL ALL SAMPLES HAVE BEEN TESTED.
  REM  5/23/90   WBA
  REM PRINT " START OF MAIN PROC ";TIME$
  RLCTR%=0  ! REMOTE LOOP COUNTER
  RL$="R"   ! SET TO REMOTE SO INIT BELOW WILL RUN IN WHILE LOOP BELOW
  Y$=""
  IF RLCTR%=0 THEN ! DO ONLY IF FIRST TIME IN ROMOTE LOOP
    WHILE Y$<>"Y"
      IF WLFLAG=1 THEN ! WORKLIST FLAG SET IN GET_DATA
        DISPLAY "              ALL WORKLIST TEST HAVE BEEN COMPLETED "
      END IF
      DISPLAY
      DISPLAY "        YOU ARE NOW IN THE AUTOMATIC MODE OF OPERATION "
      SET TIMER 1 FOR 2 SECONDS
      WAIT FOR TIMER 1
      READ MODE$ FROM "OPMODE" ! CHECK PARAMETER ENTRY MODE
      CLOSE "OPMODE"
      IF MODE$="LOCAL" THEN ! IF IN LOCAL PARAMETER ENTRY MODE
        RL$="L"
        Y$="Y"
      ELSE                    ! IF IN REMOTE PARAMETER ENTRY MODE
        IF MODE$="REMOTE" THEN ! IF IN REMOTE MODE
          RL$="R" ! SET REMOTE FLAG
          DISPLAY
          DISPLAY "   STANDBY FOR CHECK OF NETWORK OPERATION:"
          DISPLAY
          CHECKLNK ! SEE IF NETWORK OPERATIONAL
          IF LINK$="UP" THEN ! IF NETWORK OPERATIONAL
            Y$="Y"
          ELSE
            DISPLAY
            DISPLAY "      *****    NETWORK IS NOT OPERATIONAL     *****"
            DISPLAY "      TEST PARAMETERS CAN NOT BE READ FROM WORKSTATION"
            DISPLAY
            DISPLAY "  DO YOU WISH TO ENTER PARAMETERS AT THE TEST STATION";
            INPUT " (Y OR N) ";Y$
            IF Y$="Y" THEN
              RL$="L" ! SET FLAG FOR LOCAL PARAMETER ENTRY
            ELSE
              Y$="Y" ! SET FLAG TO EXIT LOOP
              DISPLAY
              DISPLAY " EXIT TEST ROUTINE"
            END IF
          END IF
        ELSE
          DISPLAY MODE$
          SET TIMER 1 FOR 5 SECONDS
          WAIT FOR TIMER 1
        END IF
      END IF
      DISPLAY
    END WHILE
  END IF
```

```
IF RL$="L" THEN ! IF LOCAL PARAMETER ENTRY
  CLEAR
  DISPLAY
  DISPLAY " YOU ARE IN THE LOCAL TEST PARAMETER ENTRY MODE"
  DISPLAY
  Y$="N"
  READ WLIST$ FROM "WLFILE" ! SEE IF WORKLISTS ALREADY EXISTS
  CLOSE "WLFILE"
  IF WLIST$="WORKLIST FOUND" THEN ! IF WORKLIST IS PRESENT
    DISPLAY
    DISPLAY "  A WORKLIST HAVING THE FOLLOWING BARCODES WAS FOUND:"
    WHILE WLIST$()"END OF WORKLISTS" ! UNTIL ALL BARCODES HAVE BEEN READ
      READ WLIST$ FROM "WORKLIST" ! READ BARCODE
      DISPLAY WLIST$
    END WHILE
    CLOSE "WORKLIST"
    Y$=""
    WHILE Y$=""
      DISPLAY
      DISPLAY "  DO YOU WANT TO RUN THESE BARCODES NOW (Y OR N)?"
      INPUT "     (N WILL DELETE THESE BARCODES) ",Y$
    END WHILE
  END IF
  IF Y$="N" THEN
    GETPARAM ! GET TEST PARAMETERS LOCALLY
  END IF
  WLFLAG=1 ! SET FLAG TO LOOK FOR WORKLISTS
ELSE       ! IF REMOTE PARAMETER ENTRY
  IF LINK$="UP" THEN ! IF NETWORK OPERATIONAL
    WLFLAG=1         ! SET FLAG TO LOOK FOR WORKLISTS
  END IF
END IF
ERRMODE ! GET ERROR RECOVERY MODE, ATTENDED OR UNATTENDED
WHILE WLFLAG=1 ! WHILE WORKLISTS ARE PRESENT
  RLCTR%=0
  IF MODE$="REMOTE" THEN ! IF IN REMOTE MODE
    CHECKLNK ! SEE IF NETWORK STILL ACTIVE
    IF LINK$="UP" THEN ! IF NETWORK STILL ACTIVE
      DISPLAY "   TRANSFERING SPEC FILES TO THE TEST STATION:"
      DOS CHKWKLST ! SEE IF WORKLISTS PRESENT
      READ WLIST$ FROM "WLFILE"
      IF WLIST$()"NO WORKLISTS FOUND" THEN
        WRITE WLIST$ TO "WLERASE.BAT" ! WRITE WORKLIST FILE NAME TO ERASE
        READ WLIST$ FROM "WLFILE"
        WRITE WLIST$ TO "WLERASE.BAT" ! WRITE WORKLIST FILE NAME TO RENAME
        CLOSE "WLERASE.BAT"
        DOS TRANSFER ! TRANSFER FROM NETWORK TO TEST STATION
      END IF
      CLOSE "WLFILE"
    END IF
  END IF
  GETWKLST ! SEE IF WORKLIST PRESENT IN \LINK\SPEC\ DIRECTORY
  WHILE SPECFLAG=1 ! WHILE BARCODES ARE PRESENT:
    GET DATA ! CALL PROC FOR RETREVING TEST DATA
    IF SPECFLAG=1 THEN ! IF BARCODE FOUND
      SAMCTX = SAMNOX ! SET SAMCT% TO LARGEST # SAMPLES TO BE RUN
      CLEAR !CLEAR SCREEN
      ALARM ON
      SET TIMER 1 FOR 1 SECOND
      WAIT FOR TIMER 1 ! SOUND ALARM JUST BEFOR ROBOT BEGINS MOVING
      ALARM OFF
      FILLHOPR ! MOVE SAMPLES FROM MAIN HOPPER TO FEED HOPPER
      IF RLCTR%=1 THEN ! IF FIRST BARCODE IN WORKLIST
        WRITE BARCODE$ TO "USEDLIST" ! RECORD CODE AS BEING USED
      ELSE
        APPEND BARCODE$ TO "USEDLIST"
```

```
        END IF
        CLOSE "USEDLIST"
        DISHEADR ! DISPLAY DATA HEADER
        PROBCTR%=0 ! CLEAR TROUBLE MESSAGE COUNTER
        WHILE SAMCT% > 0
          DLINE%=SAMNO%-SAMCT% ! CALCULATE SAMPLE # FOR DATA DISPLAY LINE
          DISPLAY ! CLEAR ANY PREVIOUS MESSAGES FROM THIS LINE
REM       DISPLAY
          CURSOR (DLINE%@17)+7,1
REM       IF DLINE%=17 THEN ! IF WRAPPING DISPLAY AROUND TO TOP
            DISPLAY ! CLEAR THIS LINE
            CURSOR (DLINE%@17)+7,1 ! MOVE BACK UP TO LINE
REM       END IF
          DISPLAY DLINE%+1; ! DISPLAY SAMPLE NUMBER
          GSAMPLE ! GET SAMPLE AND RECORD LENGTH, IF REQUIRED
          IF ((CRFLAG = 1) AND (TST2%>0)) OR ((DFLAG=1) AND (TST4%>0)) THEN
            CRTDCHK ! SEE IF INSTRUMENT IS EMPTY
            IF (TST2%>0) OR (TST4%>0) THEN ! IF INSTRUMENT IS READY
              IF FAULT$<>"S" THEN ! IF NOT SKIPPING THIS CIGARETTE
                TOTRTD ! CALL TOTAL RTD PROCEDURE
              END IF
            END IF
          END IF
          IF (CFLAG = 1) AND (TST3%>0) THEN
            CIR    ! CALL CIRCUMFERENCE PROCEDURE
          END IF
          IF ((TST5% > 0) OR (TST6% > 0)) AND (SIH%=1) THEN
            ! IF FLEN OR FRTD REQUIRED AND SAMPLE PRESENT IN HAND
            FCO  ! CALL FILTER CUT OFF PROCEDURE
          ELSE ! IF NO OTHER TEST REQUIRED
            SAFPOS ! DISCARD CIGARETTE
            OPEN
          END IF
          IF (FLFLAG = 1) AND (TST5%>0) AND (SIH%=1) THEN
            FLEN ! CALL FILTER LENGTH PROCEDURE
          END IF
          IF (FRFLAG = 1) AND (TST6%>0) AND (SIH%=1) THEN
            FRTDCHK ! SEE IF INSTRUMENT IS EMPTY
            IF (TST6%>0) THEN ! IF INSTRUMENT IS READY
              IF FAULT$<>"S" THEN ! IF NOT SKIPPING THIS FILTER
                FRTD ! CALL FILTER RTD PROCEDURE
              END IF
            END IF
          END IF
          SAMCT% = SAMCT% -1
          IF FAULT$="A" THEN ! IF ABORTING TESTING OF ALL SAMPLES
            ABORTRUN
          END IF
          R$=READKEY$ ! SEE IF KEY ENTERED
          IF R$<>"" THEN ! IF KEY ENTERED
            WHILE R$<>"" ! CLEAR KEYBOARD BUFFER
              R1$=R$ ! SAVE LAST KEY INPUT
              DISPLAY R$;
              R$=READKEY$
            END WHILE
            IF R1$="P" THEN ! IF PAUSE KEY ENTERED
              DISPLAY
              ERRSTOP$="T" ! SET FLAG TO PAUSE IN ERRRESP
              ERRRESP ! SIGNAL STOP AND GET OPERATOR RESPONSE TO CONTINUE
              ERRMODE ! ALLOW ERROR MODE TO BE CHANGED, IF NEEDED
            END IF
          END IF
        END WHILE
        CLRHOPR ! REMOVE ANY SAMPLES LEFT
        OPEN
        (CURSOR 20,1) ! MOVE CURSOR
```

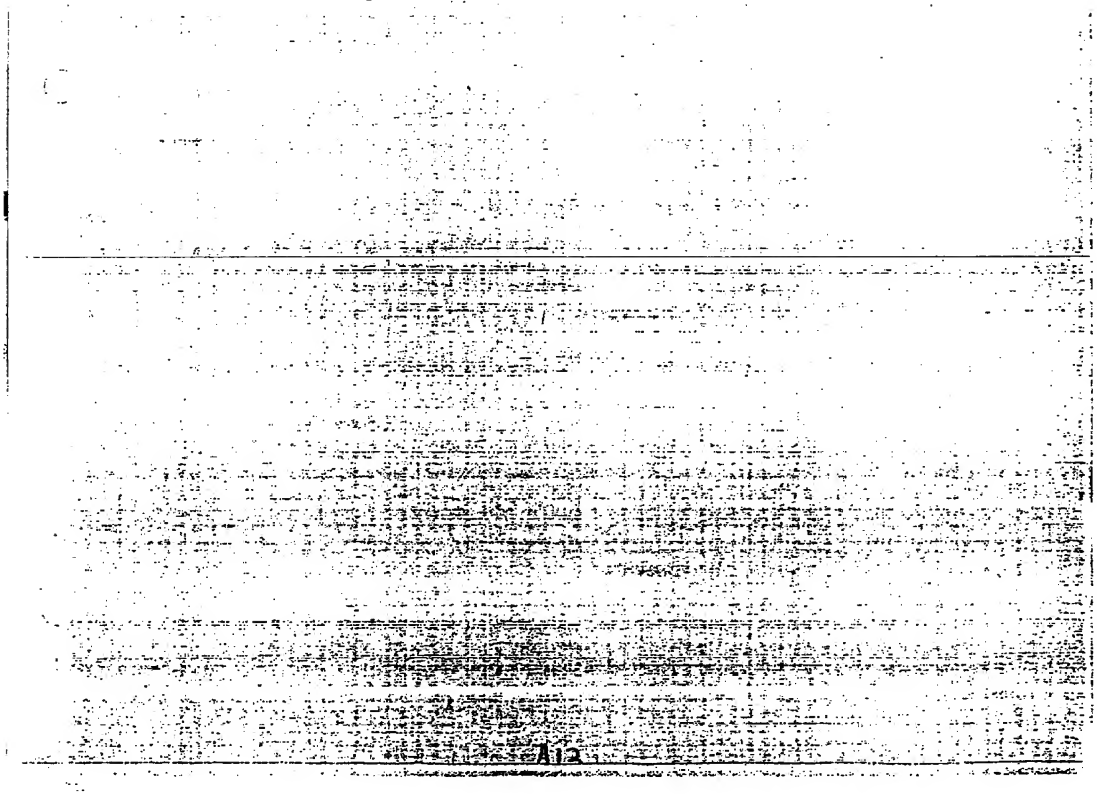
A9

```
        IF DLINE%>0 THEN ! IF DATA TAKEN
          DAT! CALL PGM TO COLLECT DATA AND STORE IN "BARCODE.DAT"
        END IF
        PCHECK ! SEE IF PAUSE ENTERED
        DISPLAY
      END IF ! END IF BARCODE FOUND
    END WHILE ! BARCODES ARE PRESENT
    IF MODE$="REMOTE" THEN
      CMD$="NO CODES"
      WRITE CMD$ TO "USEDLIST" ! CLEAR USED CODE LIST
      CLOSE "USEDLIST"
    END IF
  END WHILE ! WORKLISTS ARE PRESENT
END PROCEDURE
```

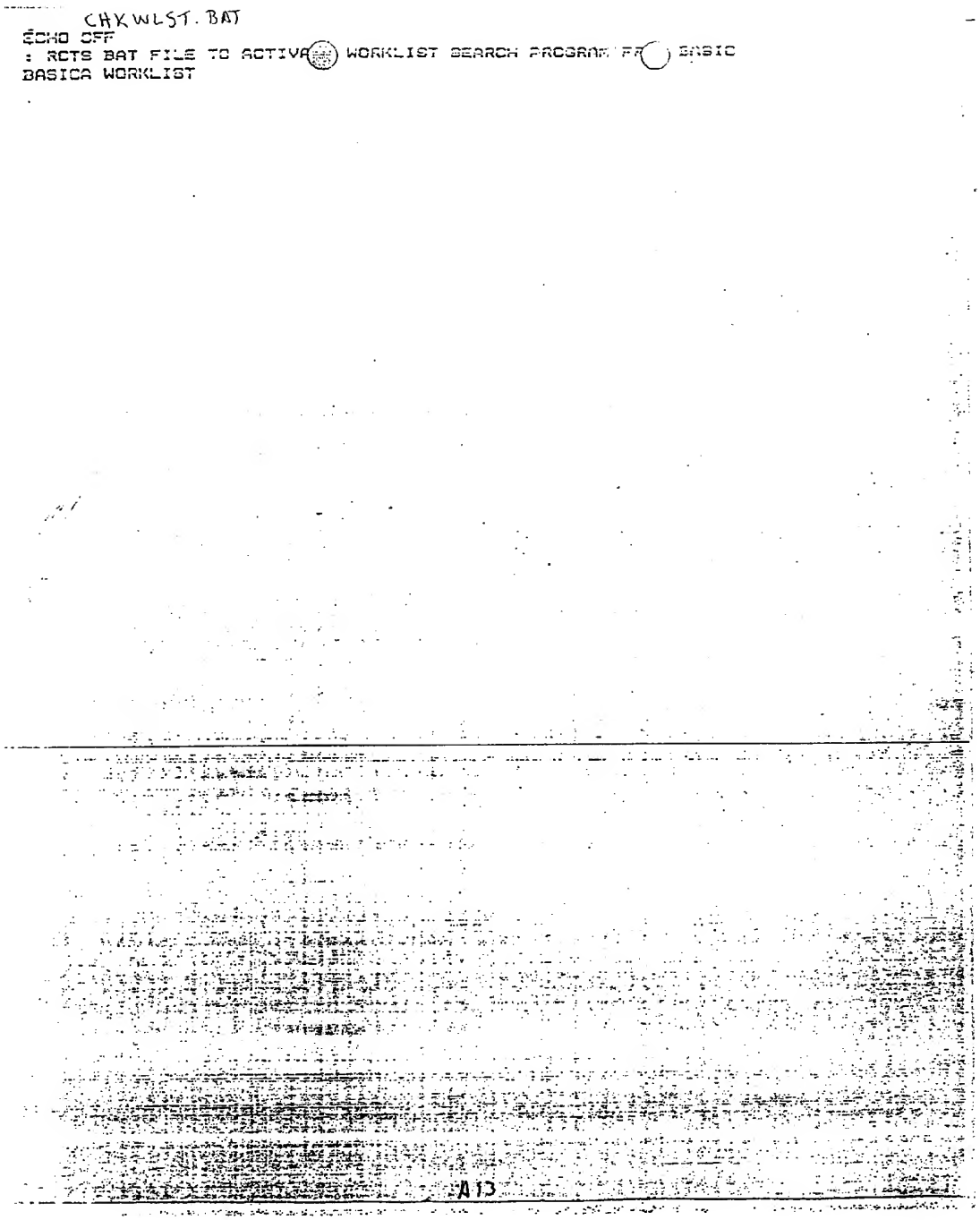
A10

```
PROCEDURE CHECKLNK
  ! THIS PROCEDURE CHECKS THE STATUS OF THE NETWORK AND SETS LINK$ TO
  ! INDICATE THAT STATUS.  THE BASIC PROGRAM "NETCHECK" IS CALLED.  IF
  ! THE NETWORK IS OPERATIONAL, THE BASIC PROGRAM RETURNS IMMEDIATELY.
  ! IF THE NETWORK IS NOT OPERATIONAL, THE BASIC PROGRAM RETURNS AFTER
  ! A TIMEOUT PERIOD.  THE STATUS OF THE NETWORK IS RETURNED IN THE FILE
  ! "LINKSTAT.DAT" AND IS SAVED IN LINK$.
  !
  DOS NETCHECK ! CHECK THE NETWORK STATUS
  READ LINK$ FROM "LINKSTAT.DAT" ! READ THE STATUS OF THE NETWORK
  CLOSE "LINKSTAT.DAT"
REM   DISPLAY LINK$
REM   SET TIMER 1 FOR 2 SECONDS
REM   WAIT FOR TIMER 1
END PROCEDURE
```

```
NETCHECK.BAT
: THIS BATCH FILE CHECKS THE NETWORK SERVER TO SEE IF IT IS OPERATIONAL
: OPERATIONAL.  IT WRITES THE STATUS OF THE NETWORK TO THE FILE
: LINKSTAT.DAT   1/19/90   WBA
:
@ ho off
  .ping pm14
IF errorlevel 1 goto netdown
:netup
        @echo UP)linkstat.dat
     @goto finish
:netdown
        @echo DOWN)linkstat.dat
:finish
```



A12



```
CHKWLST.BAT
ECHO OFF
: RCTS BAT FILE TO ACTIVATE WORKLIST SEARCH PROGRAM FROM BASIC
BASICA WORKLIST
```

A13

```
PROCEDURE ERRMODE
  REM THIS PROCEDURE ALLOWS THE OPERATOR TO SPECIFY WHETHER THE TEST STATION
  REM IS TO OPERATE IN THE ATTENDED OR THE UNATTENDED MODE.  IN GENERAL,
  REM WHEN THE ROBOT DETECTS AN OPERATIONAL PROBLEM, IT TRIES TO CORRECT THE
  REM PROBLEM.  IF IT CANNOT, IT SIGNALS THE OPERATOR AND STOPS WHEN IN THE
  REM ATTENDED MODE.  THE OPERATOR CAN THEN CORRECT THE PROBLEM AND TELL THE
  REM ROBOT TO CONTINUE.  IN THE UNATTENDED MODE, IT CONTINUES ON, BUT SKIPS
  REM THE INSTRUMENT WHICH IT THINKS HAS THE OPERATIONAL PROBLEM. 3/6/92  WEA
  REM
  R$=""
  WHILE R$=""
    DISPLAY
    DISPLAY
    INPUT "     DO YOU WANT TO STOP WHEN AN ERROR IS DETECTED (Y OR N)";R$
    CASE R$
      IS "Y":
        ERRSTOP$="T" ! SET FLAG TO STOP ON ERRORS
      IS "N":
        ERRSTOP$="F" ! SET FLAG TO CONTINUE ON ERRORS
      DEFAULT:
        R$="" ! RESET TO STAY IN LOOP
    END CASE
  END WHILE
  R$=""
  WHILE R$<>"R"
    DISPLAY
    INPUT "     ENTER R WHEN READY TO RUN: ",R$
    DISPLAY
  END WHILE
END PROCEDURE
```

A19

```
10 REM
20 REM "WORKLIST PROGRAM"
30 REM THIS PROGRAM SEARCHES FOR A WORKLIST FOR THE ROBOTIC CIGARETTE TEST
40 REM STATION.  A WORKLIST CONTAINS THE BARCODES OF THE SAMPLES TO BE TESTED,
50 REM AND IN THE ORDER TO BE TESTED.  A WORKLIST HAS THE NAME "WMMDDYY.EXT",
60 REM WHERE MMDDYY IS THE MONTH,DAY, AND YEAR THE WORKLIST WAS ENTERED INTO
70 REM THE WORKSTATION.  "EXT" IS THE SEQUENCE NUMBER OF THE WORKLIST, STARTING
80 REM AT "200" AND GOING UP TO "MAXEXT%".  THE PROGRAM FIRST READS THE FILE
90 REM "LASTLIST", TO FIND THE DATE OF THE LAST WORKLIST USED.  IT THEN STARTS
100 REM SEARCHING THE WORKSTATION DIRECTORY FOR A WORKLIST HAVING THAT NAME.
110 REM IT CONTINUES TO SEARCH, INCREMENTING THE WORKLIST NAME AND/OR EXTENSION
120 REM AS NEEDED, UNTIL A WORKLIST IS FOUND, OR UNTIL THE CURRENT DATE HAS BEEN
130 REM USED.  IF A WORKLIST IS NOT FOUND, THE MESSAGE "NO WORKLISTS FOUND" IS
140 REM STORED IN THE FILE "WLFILE", AND THE PROGRAM EXITS.  IF A WORKLIST IS
150 REM FOUND, THE BARCODES ARE TRANSFERED TO THE FILE "WORKLIST".  THE NAME OF
160 REM THE WORKLIST IS SAVED IN "WLFILE" FOR RENAMING BY THE PERL PROGRAM AFTER
170 REM THE SAMPLES HAVE BEEN TESTED. THE SPEC FILES ARE SAVED IN THE FILE
180 REM "TRANSFER.BAT", FOR TRANSFER FROM THE NETWORK TO A HOLDING DIRECTORY IN
190 REM THE TEST STATION PC.  THE NAME OF THE WORKLIST IS ALSO SAVED IN THE FILE
200 REM "LASTLIST" FOR STARTING THE NEXT WORKLIST SEARCH.     3/16/90 WBA
210 REM
220 CLOSE
230 ON ERROR GOTO 920
240 ON TIMER (3) GOSUB 980 : REM 3 SECOND TIMER FOR DISPLAY OF BARCODE
250 DA$=DATE$
260 M$=LEFT$(DA$,2)  : CURMON=VAL(M$)
270 D$=RIGHT$(DA$,7)
280 D$=LEFT$(D$,2)  : CURDAY=VAL(D$)
290 Y$=RIGHT$(DA$,4) : CURYR=VAL(Y$)
300 OPEN "\PERL\LASTLIST" FOR INPUT AS #1 : REM GET LAST WORKLIST NAME USED
310 INPUT #1,LASTLIST$
320 CLOSE #1
330 M$=LEFT$(LASTLIST$,2) : REM PRINT M$
340 D$=MID$(LASTLIST$,3,2) : REM PRINT D$
350 Y$=MID$(LASTLIST$,5,4) : REM PRINT Y$
360 DAY=VAL(D$) : REM CONVERT DAY TO NUMBER
370 MON=VAL(M$) : REM CONVERT MONTH
380 YR=VAL(Y$) : REM CONVERT YEAR
390 Y$=RIGHT$(Y$,2) : REM PRINT Y$
400 OPEN "\PERL\WORKLIST" FOR OUTPUT AS #2
410 MAXEXT%=50 : REM MAX EXTENSION NUMBER FOR WORKLIST FILES
420 I%=1
430 EXT=0 : REM INITIALIZE FILE EXTENSION
440 LASTLIST$=M$+D$+Y$ : REM FORM WORKLIST ROOT NAME
450 WL$="W"+LASTLIST$ : REM FORM WORKLIST ROOT NAME FROM MONTH,DATE,YEAR
460 TL$="T"+LASTLIST$ : REM FORM USED WORKLIST NAME
470 PRINT M$+"/"+D$+"/"+Y$ : REM DISPLAY DATE BEING SEARCHED FOR
480 IF CURYR<YR GOTO 800 : REM IF TODAY'S YR < SEARCH YR, STOP
490 IF (CURMON<=MON) AND (CURDAY<DAY) AND (YR=CURYR) GOTO 800
500 WHILE EXT<(MAXEXT%
510 EXT$ = STR$(EXT) : REM FORM FILE EXTENSION
520 EXT$ = "00"+RIGHT$(EXT$,LEN(EXT$)-1)
530 EXT$ = "."+RIGHT$(EXT$,3)
540 P$=WL$+EXT$ : REM FORM COMPLETE FILE NAME
550 OPEN "E:\"+P$ FOR INPUT AS #1
560 Q$=TL$+EXT$ : REM FORM COMPLETE USED FILE NAME
570 PRINT P$
580 OPEN "\PERL\WLFILE" FOR OUTPUT AS #3
590 PRINT #3, "DEL E:\"+Q$ : REM SAVE WORKLIST FILE NAME TO DELETE
600 PRINT #3,"REN E:\"+P$+" "+Q$ : REM SAVE WORKLIST FILE NAME TO RENAME
610 CLOSE #3
620 OPEN "\PERL\TRANSFER.BAT" FOR OUTPUT AS #3
630 IF EOF(1) THEN CLOSE #1: CLOSE #3: GOTO 740
640 INPUT #1,BARCODE$
650 PRINT #2,BARCODE$
660 PRINT #3, "COPY E:\"+BARCODE$+".SPE\LINK\SPEC" : REM SAVE SPEC FILE NAME TO COPY
```

A-15

```
670 PRINT #3,"DEL F:\"+BARCODE$+".SPE" : REM SAVE SPECIFIC NAME TO DELETE
680 PRINT "#";I%;"BARCODE = ";BARCODE$
690 TIMER ON : REM ACTIVATE DELAY TIMER WHILE CODE DISPLAYED
700 GOTO 700 : REM WAIT FOR TIMER TO EXPIRE
 10 TIMER OFF : REM STOP TIMER
720 I%=I%+1 : REM INCREMENT CODE COUNTER
730 GOTO 630
740 IF I% > 1 THEN EXT=MAXEXT% : REM IF BARCODE FOUND IN WORKLIST
750 EXT=EXT + 1 : REM INCREMENT EXTENSION
760 WEND
770 IF I% > 1 THEN GOTO 630 : REM IF BARCODES FOUND IN WORKLIST
780 GOSUB 1000 : REM INCREMENT WORKLIST NAME TO NEXT DATE
790 GOTO 430 : REM REPEAT SEARCH
800 OPEN "\PERL\WLFILE" FOR OUTPUT AS #3
810 PRINT #3,"NO WORKLISTS FOUND": CLOSE #3
820 GOTO 900
830 PRINT #2,"END OF WORKLISTS" : REM INDICATE END OF WORKLIST
840 CLOSE #2
850 Y$=STR$(YR) : Y$=RIGHT$(Y$,LEN(Y$)-1)
860 LASTLIST$=M$+D$+Y$ : REM FORM NAME OF LAST WORKLIST FOUND
870 OPEN "\PERL\LASTLIST" FOR OUTPUT AS #2
880 PRINT #2,LASTLIST$ : REM SAVE NAME OF LAST WORKLIST FOUND
890 CLOSE #2
900 CLOSE
910 SYSTEM
920 REM
930 REM ERROR HANDLING SUBROUTINE
940 REM
950 IF (ERR=53) THEN RESUME 750 : REM IF FILE DOES NOT EXIST
960 IF (ERR=55) THEN PRINT " FILE ALREADY OPEN ":RESUME NEXT
970 PRINT "ERROR";ERR : RESUME NEXT
980 RETURN 710 : REM RETURN AFTER DELAY FOR DISPLAYING BARCODE
990 END
1000 REM
1010 REM INCREMENT WORKLIST NAME TO NEXT DATE
1020 REM
1030 DAY=DAY+1 : REM INCREMENT TO NEXT DAY
1040 IF (DAY < 29) GOTO 1160 : REM IF NOT END OF MONTH, CONTINUE SEARCH
1050 IF MON<>2 THEN GOTO 1100 : REM IF NOT FEBRUARY, CONTINUE SEARCH
1060 IF ((YR MOD 4)=0) AND (DAY<30) GOTO 1160 : REM IF 2/29 OF LEAP YEAR
1070 MON=3 : REM SET MONTH TO MARCH IF NOT 2/29 OF LEAP YEAR
1080 DAY=1 : REM RESET DAY
1090 GOTO 1160 : REM CONTINUE SEARCH
1100 IF DAY < 31 GOTO 1160 : REM IF NOT END OF MONTH
1110 IF (MON=1) OR (MON=3) OR (MON=5) OR (MON=7) OR (MON=8) OR (MON=10) OR (MON=
12) GOTO 1140 : REM IF JAN,MAR,MAY,JUL,AUG,OCT,DEC
1120 GOSUB 1190
1130 GOTO 1160
1140 IF DAY <> 32 GOTO 1160 : REM IF NOT END OF MONTH
1150 GOSUB 1190 : REM IF END OF MONTH, INCREMENT MONTH
1160 D$=STR$(DAY) : D$="0"+RIGHT$(D$,LEN(D$)-1) : D$=RIGHT$(D$,2)
1170 M$=STR$(MON) : M$="0"+RIGHT$(M$,LEN(M$)-1) : M$=RIGHT$(M$,2)
1180 RETURN
1190 REM
1200 REM INCREMENT MONTH AND YEAR
1210 REM
1220 DAY=1
1230 MON=MON+1
1240 IF MON<13 GOTO 1290 : REM IF NOT DECEMBER
1250 YR=VAL(Y$)
1260 YR=YR+1 : REM INCREMENT YEAR
1270 Y$=STR$(YR) : Y$="0"+RIGHT$(Y$,LEN(Y$)-1) : Y$=RIGHT$(Y$,2)
1280 MON=1 : REM SET MON TO JAN
1290 RETURN
```

```
PROCEDURE GETWKLST
  ! THIS PROCEDURE IS USED WHEN IN THE REMOTE PARAMETER ENTRY MODE, TO LOOK
  ! FOR THE WORKLIST, AND IF FOUND, TO TRANSFER IT FROM THE NETWORK SERVER TO
  ! A DIRECTORY ON THE PC, WHERE IT CAN BE USED BY THE TEST STATION.  IT ALSO
  ' TRANSFERS THE TEST SPEC FILES. 1/15/92 WBA

  IF RLCTR%=0 THEN ! IF FIRST TIME THRU LOOP
    CLEAR
REM CURSOR 5,1
    DISPLAY "                    LOOKING FOR WORKLIST"
REM DISPLAY
REM CMD$="BASICA WORKLIST"
REM WRITE CMD$ TO "TRANSFER.BAT"
REM CLOSE "TRANSFER.BAT"
REM DOS TRANSFER.BAT ! LOOK FOR WORKLISTS
REM DOS CHKWKLST ! LOOK FOR WORKLISTS
    READ WLIST$ FROM "WLFILE"
    IF WLIST$="NO WORKLISTS FOUND" THEN
      WLFLAG=0 ! SET FLAG FOR NO WORKLISTS
      SPECFLAG=0
      DISPLAY
      DISPLAY "      *****      NO WORKLISTS FOUND      *****"
      DISPLAY
    ELSE
      WLFLAG=1 ! SET FLAG FOR WORKLIST FOUND
      SPECFLAG=1 ! SET FLAG TO LOOK FOR SPEC FLAG
REM   WRITE WLIST$ TO "WLERASE.BAT" ! WRITE WORKLIST FILE NAME TO ERASE FILE
REM   READ WLIST$ FROM "WLFILE" ! GET NAME OF WORKLIST FILE NAME TO RENAME
REM   WRITE WLIST$ TO "WLERASE.BAT"
REM   CLOSE "WLERASE.BAT"
REM   BARCODE$=""
REM   WHILE BARCODE$<>"END OF WORKLISTS" ! UNTIL END OF WORKLIST REACHED
REM     READ BARCODE$ FROM "WORKLIST" ! READ BARCODE
REM     IF BARCODE$<>"END OF WORKLISTS" ! IF NOT END OF WORKLIST
REM       CMD$="COPY F:"+BARCODE$+".SPE \LINK\SPEC" ! CMD TO COPY TO HOLD DIR
REM       WRITE CMD$ TO "TRANSFER.BAT" ! WRITE COMMAND TO TRANSFER FILE
REM       IF EOF("WORKLIST")=1 THEN ! IF EOF THEN
REM         BARCODE$="END OF WORKLISTS" ! SET TO EXIT LOOP
REM       END IF
REM     END IF
REM   END WHILE ! UNTIL END OF WORKLIST REACHED
REM   CLOSE "TRANSFER.BAT"
REM   DOS TRANSFER ! EXECUTE TRANSFER OF SPEC FILES TO HOLDING DIRECTORY
    END IF
    CLOSE "WLFILE"
  END IF ! FIRST TIME THRU LOOP
END PROCEDURE
```

```
PROCEDURE USEDCHK
  ! THIS PROCEDURE IS USED TO SEE IF A WORKLIST WAS ACTED BEFORE IT WAS
  ! COMPLETED. IT READS THE ENTRIES IN THE WORKLIST AND COMPARES THEM TO A
  ! LIST OF USED CODES. WHEN AN UNUSED CODE IS FOUND, IT IS THE FIRST CODE TO
  ! BE TESTED, SKIPPING OVER THE CODES ALREADY USED.   2/21/90 WEA

  IF RLCTR%=0 THEN ! IF FIRST TIME THRU LOOP
    I%=0 ! SET COUNTER TO STAY IN LOOP
    WHILE I%=0
      READ BARCODE$ FROM "WORKLIST" ! GET BARCODE FROM WORKLIST
      READ USEDCODE$ FROM "USEDLIST" ! GET USED BARCODE
      IF BARCODE$<>"END OF WORKLISTS" THEN ! IF NOT END OF WORKLIST
        IF BARCODE$<>USEDCODE$ THEN ! IF CODE NOT USED YET
          I%=1 ! SET FLAG TO EXIT LOOP
        ELSE
          RLCTR%=RLCTR%+1 ! INCREMENT USED CODE COUNTER
          IF RLCTR%=1 THEN ! IF FIRST USED BARCODE FOUND
            DISPLAY "USED BARCODES FOUND IN THIS WORKLIST: "
          END IF
          DISPLAY BARCODE$ ! DISPLAY USED BARCODE
          IF EOF("USEDLIST")=1 THEN ! IF END OF USED CODE LIST
            I%=1 ! EXIT LOOP
          END IF
        END IF
      ELSE ! IF END OF WORKLIST
        I%=1 ! EXIT LOOP
      END IF
    END WHILE
    CLOSE "USEDLIST"
    IF RLCTR%=0 THEN ! IF NO USED CODES FOUND
      CLOSE "WORKLIST" ! CLOSE FILE TO RESTART ON READ
    ELSE
      SET TIMER 1 FOR 2 SECONDS ! PAUSE FOR DISPLAY OF USED BARCODES
      WAIT FOR TIMER 1
    END IF
  END IF ! FIRST TIME THROUGH LOOP
REM  DISPLAY RLCTR%
REM  DISPLAY BARCODE$
REM  DISPLAY USEDCODE$
REM  SET TIMER 1 FOR 2 SECONDS
REM  WAIT FOR TIMER 1
END PROCEDURE
```

A18

```
PROCEDURE GET_DATA
  REM THIS PROCEDURE READS THE SPEC FILE DATA AND SAVES IT FOR USE IN TESTING
  REM SAMPLES.    5/15/90 WBA
  REM
  SPECDR$="\LINK\SPEC\" ! DIRECTORY LOCATION OF SPEC FILES
   F RLCTR%=0 THEN ! IF FIRST TIME THROUGH LOOP
    IF MODE$="REMOTE" THEN ! IF IN REMOTE MODE
      USEDCHK ! SEE IF ANY BARCODES ALREADY RUN IN THIS WORKLIST
    END IF
  END IF
    RLCTR%=RLCTR%+1 ! INCR REMOTE LOOP COUNTER
    READ BARCODE$ FROM "WORKLIST"
    SPFILENAME$=SPECDR$+BARCODE$+".SPE"
    IF BARCODE$<>"END OF WORKLISTS" THEN
      CLEAR
      DISPLAY
      DISPLAY "                LOOKING FOR TEST SPECIFICATION FILE"
      DISPLAY
      SPECFLAG=1 ! SET FLAG FOR BARCODE FOUND
REM   CMD$="COPY "+SPECDR$+SPFILENAME$+" \PERL"
REM   WRITE CMD$ TO "TRANSFER.BAT"
REM   CLOSE "TRANSFER.BAT"
REM   DOS TRANSFER.BAT ! COPY BARCODE TEST DATA TO PERL
      CTR%=0
      RODCHECK%=1 ! SET FLAG TO COMPARE ACTUAL ROD LENGTH TO EXPECTED
      RLFLAG=0
      CRFLAG=0
      CFLAG=0
      DFLAG=0
      FLFLAG=0 ! REINIT FLAGS
      FRFLAG=0
      SAMNO%=0
      CIGLEN%=0
      FILLEN%=0
      TST1%=0
      TST2%=0
      TST3%=0
      TST4%=0
      TST5%=0
      TST6%=0
      T1%=0
      T2%=0
      T3%=0
      T4%=0
      T5%=0
      T6%=0
      FOR I%=1 TO 25
        READ D$ FROM SPFILENAME$
        IF EOF (SPFILENAME$)=1 THEN
          I%=25 ! SET FOR I% CNTR TO 25 IF END OF FILE
        END IF
        A%=LEN(D$)          ! SET A = TO LENGTH OF STRING
        Z$="."              ! SET Z$ = TO CHAR TO LOOK FOR
        Z1$=INSTR(D$,Z$)    ! FIND POS OF SPACE
        B%=VAL(Z1$)         ! SET B = TO VAL OF POS OF SPACE
        T$=LEFT$(D$,B%)     ! GET DATA DESCRIPTOR STRING
        DISPLAY "DATA STRING = ";
        display d$
REM     DISPLAY "T$) = ";T$;
        IF B%=0 THEN        ! IF SPACE NOT FOUND IN STRING
          DISPLAY D$;
          DISPLAY "SPEC FILE ERROR"
          INPUT "WHAT IS PROPER DATA",D$
        ELSE
          D$=RIGHT$(D$,A%-B%) ! GET REMAINDER OF STRING
```

A19

```
REM       DISPLAY "D$ = ";D$
          CASE T$
            IS "BC ": ! BARCODE
              BCODE$=D$
REM         IS "LENGTH ": ! CIGARETTE LENGTH
            IS "CLENGTH ":
              CIGLEN%=VAL(D$)
REM         IS "TIPP_LEN ": ! TIPPING LENGTH
            IS "FLENGTH ":
              FILLEN%=VAL(D$)
            IS "TEST ": ! TEST SPECIFICATION
              A%=LEN(D$)          ! SET A = TO LENGTH OF STRING
              Z1$=INSTR(D$,Z$)    ! FIND POS OF = SIGN
              B%=VAL(Z1$)         ! SET B = TO VAL OF POS OF SPACE
              T$=RIGHT$(D$,A%-B%) ! GET NUMBER OF TEST TO BE RUN
              IF B%)1 THEN
                D$=LEFT$(D$,B%-1)    ! GET NAME OF TEST
              END IF
              CASE D$
              IS "CIG_LEN" :
                RLFLAG=1 ! SET ROD LENGTH FLAG
                TST1% = VAL(T$)
                WRITE D$ TO "CL.DAT" ! WRITE TEST NAME TO DATA FILE
                CLOSE "CL.DAT"
REM             END IF
                IS "TOT_RTD":
                  CRFLAG=1 ! SET TOT RTD FLAG
                  TST2% = VAL(T$)
                  WRITE D$ TO "CRTD.DAT" ! WRITE TEST NAME TO DATA FILE
                  CLOSE "CRTD.DAT"
REM             END IF
                IS "CIRC":
                  CFLAG=1  ! SET CIRCUMFERENCE FLAG
                  TST3% = VAL(T$)
                  WRITE D$ TO "CD.DAT" ! WRITE TEST NAME TO DATA FILE
                  CLOSE "CD.DAT"
REM             END IF
                IS "VENT_PER":
                  DFLAG=1  ! SET DILUTION FLAG
                  TST4% = VAL(T$)
                  WRITE D$ TO "DIL.DAT" ! WRITE TEST NAME TO DATA FILE
                  CLOSE "DIL.DAT"
REM             END IF
                IS "FLT_LEN":
                  FLFLAG=1 ! SET FILTER LENGTH FLAG
                  TST5% = VAL(T$)
                  WRITE D$ TO "FL.DAT" ! WRITE TEST NAME TO DATA FILE
                  CLOSE "FL.DAT"
REM             END IF
                IS "FLT_RTD":
                  FRFLAG=1 ! SET FILTER RTD FLAG
                  TST6% = VAL(T$)
                  WRITE D$ TO "FRTD.DAT" ! WRITE NAME TO TEST DATA FILE
                  CLOSE "FRTD.DAT"
REM             END IF
                DEFAULT:
                  DISPLAY "TEST SPEC ERROR"
                END CASE
                IF VAL(T$))SAMNO% THEN ! IF # SAMPLES FOR THIS TEST ) TOTAL #
                  SAMNO%=VAL(T$) ! SAVE AS NEW TOTAL #
                END IF
              DEFAULT:
                DISPLAY "SPEC FILE ERROR"
            END CASE
          END IF
```

A20

NEXT 1%

```
        CLOSE SPFILENAME$
        CMD$="COPY "+SPFILENAME$+" "+SPECDR$+BARCODE$+".TPE"
        APPEND CMD$ TO "WLERASE.BAT" ! ADD SPECFILE NAME TO RENAME LIST
        CMD$="DEL "+SPFILENAME$ ! DELETE SPEC FILE
        APPEND CMD$ TO "WLERASE.BAT"
        CLOSE "WLERASE.BAT"
        IF SAMNO%=0 THEN ! IF NO TESTS FOUND IN LIST
          DISPLAY
          DISPLAY " NO TESTS WERE REQUESTED FOR THIS SAMPLE"
          DISPLAY
          ERRRESP
        END IF
        WHILE (CIGLEN%<77) OR (CIGLEN%>120) ! GET CIGARETTE LENGTH ENTRY
          DISPLAY
          DISPLAY " *** NO CIGARETTE LENGTH FOUND IN SPEC FILE ***"
          ALARM_ON
          SET TIMER 1 FOR 1 SECOND
          WAIT FOR TIMER 1
          ALARM_OFF
          MSG$="      ENTER CIGARETTE LENGTH (MM) "
          GETKEY ! GET OPERATOR RESPONSE
          CIGLEN%=VAL(IN$) ! CONVERT REPONSE TO NUMERIC
        END WHILE
        WHILE (FILLEN%<18) OR (FILLEN%>36) ! GET FILTER LEN ENTRY
          DISPLAY
          DISPLAY " *** NO FILTER LENGTH FOUND IN SPEC FILE ***"
          ALARM_ON
          SET TIMER 1 FOR 1 SECOND
          WAIT FOR TIMER 1
          ALARM_OFF
          MSG$="      ENTER FILTER LENGTH (MM) "
          GETKEY ! GET OPERATOR RESPONSE
          FILLEN%=VAL(IN$) ! CONVERT TO NUMERIC
        END WHILE
      ELSE ! IF BARCODE NOT FOUND
        SPECFLAG=0 ! RESET BARCODE FLAG
        CLOSE "WORKLIST"
        DISPLAY
        DISPLAY "      *****      NO MORE BARCODES FOUND IN THIS LIST      *****"
        DISPLAY "                 ERASING TEST SPECIFICATION FILES"
        DISPLAY
        CMD$="NO WORKLISTS FOUND"
        WRITE CMD$ TO "WLFILE" ! SET FLAG FOR WORKLIST FINISHED
        CLOSE "WLFILE"
        DOS WLERASE ! ERASE WORKLIST AND SPEC FILES
      END IF ! IF BARCODE FOUND
REM  END IF ! IF WORKLIST FOUND
END PROCEDURE
```

```
PROCEDURE GETKEY
  ! THIS PROCEDURE ALLOWS ENTRY OF DATA FROM KEYBOARD CHARACTER AT A TIME.
  !    1/29/90   WBA
  !
  KEY$="A"
  WHILE ASC(KEY$)<>13 ! UNTIL CARRIAGE RETURN INPUT
    IN$=""
    DISPLAY MSG$;
    NUMERIC%=1 ! SET FLAG TO GET NUMERIC DATA
    WHILE (NUMERIC%=1) AND (ASC(KEY$)<>13) ! WHILE NUMERIC DATA INPUT
      KEY$ = INKEY$ ! GET KEY
      IF ASC(KEY$)<>13 THEN ! IF NOT CARRIAGE RETURN
        DISPLAY KEY$; ! ECHO CHARACTER
        IF (ASC(KEY$)>47) AND (ASC(KEY$)<58) THEN ! IF NUMERIC CHARACTER
          IN$=IN$+KEY$ ! FORM STRING
        ELSE
          KEY$="A"
          NUMERIC%=0 ! SET FLAG FOR NON-NUMERIC DATA
          DISPLAY
          DISPLAY
          DISPLAY "    ***    NUMERIC DATA REQUIRED    ***"
          DISPLAY
        END IF
      END IF
    END WHILE
  END WHILE
REM  DISPLAY "    IN$ = ";IN$
REM  SET TIMER 1 FOR 2 SECONDS
REM  WAIT FOR TIMER 1
END PROCEDURE
```

A22

```
PROCEDURE LOGPROB
  D$=DATE$+" "+TIME$+" " ! GET DATE AND TIME
  D$=D$+"CIGARETTE #"+STR$(DLINE%+1)+" " ! ADD SAMPLE NUMBER
  PROB$=D$+PROB$ ! ADD PROBLEM MESSAGE TO STRING
  IF PROBCTR%=0 THEN ! IF NO ENTRY LOGGED YET
    WRITE PROB$ TO "TROUBLE.DAT"
  ELSE
    APPEND PROB$ TO "TROUBLE.DAT"
  END IF
  CLOSE "TROUBLE.DAT"
  PROBCTR%=PROBCTR%+1 ! INCREMENT PROBLEM COUNTER
END PROCEDURE
```

A23

```
PROCEDURE FILLHOPR
  ! THIS PROCEDURE MOVES CIGARETTE FROM THE MAIN ROTATING HOPPER TO THE FEED
  ! HOPPER
  !
  S9=IN9  ! READ INPUT
  WHILE S9 = 0  ! DO NOTHING IF HOPPER BUSY
    DISPLAY "WAITING FOR HOPPER TO FINISH"
    S9=IN9
  END WHILE
  IF S9 = 1 THEN
    SW6_ON   ! TURN ON HOPPER
    WHILE S9=1  ! WAIT FOR HOPPER TO GO ACTIVE
      S9=IN9
    END WHILE
    SW6_OFF ! TURN HOPPER OFF
REM HOP4 ! MOVE ROBOT INTO POSITION
    WHILE S9=0  ! WAIT FOR HOPPER TO FINISH
      S9=IN9
    END WHILE
    FEEDSAMP  ! PRIME SAMPLE FEEDER
  END IF
END PROCEDURE
```

A24

```
PROCEDURE FEEDSAMP
REM  DISPLAY "FEEDSAMP"
  FEEDCHK ! WAIT UNTIL FEEDER IS NOT BUSY
  S8=IN8 ! READ FEEDER STATUS
  IF S8 = 1 THEN
    SW7_ON      ! TURN ON FEEDER
    SET TIMER 1 FOR 2 SECONDS  ! WAIT FOR FEEDER TO GO ACTIVE
    WAIT FOR TIMER 1
    SW7_OFF     ! TURN FEEDER OFF
  END IF
REM  DISPLAY "END FEEDSAMP"
END PROCEDURE
```

```
PROCEDURE FEEDCHK
  S8=IN8  ! READ INPUT
  SW7_OFF ! TURN OFF FEEDER
REM  DISPLAY "FEEDCHK ";
  IF S8=0 THEN
    DISPLAY
    DISPLAY "WAITING FOR FEEDER TO FINISH"
  END IF
  WHILE S8 = 0  ! DO NOTHING IF FEEDER BUSY
    S8=IN8
REM DISPLAY S8;
    SET TIMER 1 FOR 1 SECOND
    WAIT FOR TIMER 1
  END WHILE
END PROCEDURE
```

A26

```
PROCEDURE DISHEADR
  CLEAR
  NUMSAMP%=6 ! SET LINE TO DISPLAY # OF SAMPLES
  DISPLAY DATE$,TIME$
REM  DISPLAY
  DISPLAY "BARCODE = ";BCODE$
  DISPLAY "SAMPLE SIZE = ";SAMNO%,;
  DISPLAY "CIGARETTE LENGTH = ";CIGLEN%," FILTER LENGTH = ";FILLEN%
  DISPLAY
  DISPLAY "    CIG LEN    TOT RTD    VENT    CIRC    FIL LEN    FLT RTD"
  CURSOR NUMSAMP%,6
  DISPLAY "("+TST1%+")"; ! DISPLAY # CIG LEN SAMPLES
  CURSOR NUMSAMP%,17
  DISPLAY "("+TST2%+")"; ! # CRTD SAMPLES
  CURSOR NUMSAMP%,27
  DISPLAY "("+TST4%+")"; ! # VENT SAMPLES
  CURSOR NUMSAMP%,35
  DISPLAY "("+TST3%+")"; ! # CIRC SAMPLES
  CURSOR NUMSAMP%,44
  DISPLAY "("+TST5%+")"; ! # FLEN SAMPLES
  CURSOR NUMSAMP%,55
  DISPLAY "("+TST6%+")"; ! # FRTD SAMPLES
REM  SET TIMER 1 FOR 9 SECONDS
REM  WAIT FOR TIMER 1
END PROCEDURE
```

A27

```
PROCEDURE GSAMPLE
  ! THIS PROCEDURE FEEDS A SAMPLE FROM THE FEED HOPPER TO THE ROBOT PICKUP
  ! PT.  THE LENGTH CAMERA IS USED TO DETECT THE PRESENCE OF THE SAMPLE, AND
  ! IF REQUIRED, THE LENGTH IS READ AND RECORDED.  IF THE SAMPLE IS NOT
  ! DETECTED, THE SYSTEM WILL ATTEMPT 2 OTHER FEEDS BEFORE INDICATING A
  ! PROBLEM AND HALTING OPERATION.  THE OPERATOR CAN THEN MAKE REPAIRS, OR
  ! ABORT THE SYSTEM OPERATION
  !
  SPEED 9
  OPEN
  TRY_CTR%=0
  FAULT$=""
REM  PRINT "FEEDIN SAMPLE ";TIME$ ! *****
  GETLEN ! SEE IF SAMPLE ALREADY THERE **** REMOVE AFTER TESTING
  IF VAL(CLEND$) < 77 THEN ! IF SAMPLE NOT THERE
    FEEDSAMP ! FEED SAMPLE OUT OF HOPPER
  END IF
REM  HOP4
  CONTINUOUS
    HOP2
    HOP3
  END CONTINUOUS
  WHILE VAL(CLEND$) < 77
    GETLEN ! SEE IF SAMPLE PRESENT ******
    IF VAL(CLEND$) < 77 THEN ! IF SAMPLE NOT PRESENT
      TRY_CTR%=TRY_CTR%+1
      IF TRY_CTR% < 3 THEN ! IF NOT THIRD ATTEMPT
        ALARM_ON ! SOUND ALARM
        SET TIMER 1 FOR 1 SECONDS
        WAIT FOR TIMER 1
        ALARM_OFF
        FEEDSAMP ! TRY AGAIN TO FEED SAMPLE
        SET TIMER 1 FOR 2 SECONDS
        WAIT FOR TIMER 1
      ELSE
        FEEDCHK ! WAIT FOR FEEDER TO STOP
        DISPLAY
        DISPLAY "     ********** "
        DISPLAY "SAMPLE DID NOT FEED"
        DISPLAY "CHECK FEED OPERATION"
        DISPLAY "CHECK FOR SAMPLES IN FEED HOPPER"
        SET TIMER 1 FOR 1 SECONDS
        WAIT FOR TIMER 1
        ERRRESP ! GET OPERATOR'S INSTRUCTIONS FOR WHAT TO DO NEXT
        IF FAULT$="C" THEN ! IF TO CONTINUE WITH THIS BARCODE
          TRY_CTR%=0 ! RESET COUNTER
          FEEDSAMP  ! FEED AGAIN
        END IF
        IF FAULT$<>"C" THEN ! IF NOT TO CONTINUE
          CLEND$="80" ! SET TO EXIT LOOP
        END IF
      END IF
    END IF
  END WHILE
  IF FAULT$="S" THEN ! IF SKIPPING THIS CIGARETTE PICKUP
    PROB$="CIGARETTE DID NOT FEED; SAMPLE ABORTED BY ROBOT" ! TROUBLE MESSAGE
    LOGPROB ! LOG THE PROBLEM IN THE TROUBLE FILE
    FAULT$="F" ! SET TO NOT ATTEMPT PICK UP
    SAMCTX=1%! RESET VARIABLES TO ABORT THE REST OF THIS SAMPLE
    TST1%=0
    TST2%=0
    TST3%=0
    TST4%=0
    TST5%=0
    TST6%=0
```

A18

```
    END IF
    IF FAULT$()"F" THEN ! IF NOT GOING TO NEXT BARCODE
      IF FAULT$()"A" THEN ! IF NOT ABORTING RUN
REM PRINT "PICKING UP SAMPLE ";TIME$ ! *****
        RLEN ! GET AND SAVE LENGTH DATA ****
        HOP1 ! MOVE TO PICKUP PT
        CLOSE
        SIH%=1 ! SET FLAG FOR SAMPLE IN HAND
      END IF
    END IF
    HOP3
    HOP4
REM PRINT " PICKUP COMPLETED ";TIME$ ! *****
END PROCEDURE
```

A11

```
PROCEDURE ERRRESP
  ! THIS PROCEDURE GETS THE OPERATOR'S INSTRUCTIONS ON WHAT THE ROBOT SHOULD
  ! DO FOLLOWING DETECTION OF AN ERROR.  THE CHOICES ARE:
  ! "F" - TO ABORT TESTING OF THE CURRENT BARCODE AND START WITH THE NEXT
  ! "A" - TO ABORT TESTING OF THE CURRENT BARCODE AND ALL REMAINING BARCODES
  ! "C" - COMPLETE TESTING OF THE CURRENT BARCODE
  !
  ALARM_ON ! INDICATE OCCURANCE OF ERROR CONDITION
  SET TIMER 1 FOR 1 SECONDS
  WAIT FOR TIMER 1
  ALARM_OFF
  IF ERRSTOP$="T" THEN ! IF STOPPING ON DETECTED ERRORS
    FAULT$=""
  ELSE
    FAULT$="S" ! SET FAULT RESPONSE TO SKIP CURRENT OPERATION
  END IF
  WHILE FAULT$=""
    DISPLAY
    DISPLAY "ENTER C TO CONTINUE TESTING OF THE CURRENT BARCODE,"
    DISPLAY "      F TO STOP TESTING OF THIS BARCODE AND START WITH THE NEXT,"
    DISPLAY "      A TO ABORT TESTING OF THIS AND ALL REMAINING BARCODES"
    DISPLAY
    INPUT "WHAT SHOULD I DO"; FAULT$
    DISPLAY
    CASE FAULT$
      IS "C":
        DISPLAY "CONTINUING TESTING"
        REM FEEDSAMP  ! FEED AGAIN
      IS "F":
        DISPLAY "ABORTING THIS BARCODE AND GOING TO THE NEXT"
        PROB$=" SAMPLE ABORTED BY OPERATOR" ! CREATE TROUBLE MESSAGE
        LOGPROB ! LOG IN TROUBLE FILE
        SAMCTX=1 ! SET FLAGS AND COUNTERS TO ABORT THIS BARCODE
        TST1X=0
        TST2X=0
        TST3X=0
        TST4X=0
        TST5X=0
        TST6X=0
      IS "A":
        DISPLAY "ABORTING THIS BARCODE AND ALL REMAINING BARCODES"
        PROB$=" RUN ABORTED BY OPERATOR" ! CREATE TROUBLE MESSAGE
        LOGPROB ! SAVE IN TROUBLE FILE
        SAMCTX=1
        TST1X=0
        TST2X=0
        TST3X=0
        TST4X=0
        TST5X=0
        TST6X=0
        SIHX=0
      DEFAULT:
        FAULT$="" ! RESET TO STAY IN LOOP
    END CASE
  END WHILE
END PROCEDURE
```

A30

```
PROCEDURE GETLEN
!   THIS PROCEDURE READS THE ROD LENGTH CAMERA AND CONVERTS THE READING TO A
!   LENGTH VALUE.  THE # OF PIXELS TO THE BEST LEFT DARK EDGE IS RECEIVED FROM
!   FROM THE CAMERA, WITH 239.99 REPRESENTING THE RIGHTMOST EDGE OF THE FIELD-
!   OF-VIEW, AND 0 REPRESENTING THE LEFTMOST.  THIS VALUE IS CONVERTED TO MM,
    WITH 50 MM BEING THE MAXIMUM FIELD OF VIEW.  THE VALUE CALCULATED IS ADDED
!   TO THE OFFSET OF 75 MM, AND IS ROUNDED BY .005 MM, TO GET THE NEAREST
!   HUNDRETH MM.
!
  DEFINE CL$ AS CLEN
  CL$="XMZ" ! SEND 'WAKE UP' MESSAGE
REM  CURSOR 22,40
REM  DISPLAY CL$;
  SEND CL$
  RECEIVE CL$
REM  DISPLAY " ";CL$;
REM  CL$="XTL9" ! MESS TO SEND RIGHTMOST LEFT DARK EDGE
     CL$="XTL0" ! MESS TO SEND BEST LEFT DARK EDGE
REM  CL$="XTWB00" ! GET BRIGHT WIDTH
REM DISPLAY " ";CL$;
    SEND CL$
    RECEIVE CL$
REM DISPLAY " ";CL$;
    CL$="T"     ! SEND MESS TO TRANSMIT DATA TO GAUGE
REM DISPLAY " ";CL$;
    SEND CL$
    RECEIVE CL$ ! RECIEVE CIG LENGTH DATA
REM DISPLAY " ";CL$
REM DISPLAY "CL$ = ";CL$
    CLEND$=RIGHT$(CL$,6) ! GET RID OF UNWANTED CHARS
    RL=239.99-(VAL(CLEND$)) ! CONVERT TO VALUE: 239.99=RIGHTMOST, 0=LEFTMOST
    RL=((RL*50)/239.99)+75.005 ! DO MATH TO CONVERT CIG LEN DATA
REM DISPLAY RL;
REM RL=VAL(CLEND$) ! USE THIS CONVERSION WHEN READING WIDTH
REM RL=((RL*50)/239.99)
REM DISPLAY "RL = ";RL
    CLEND$=STR$(RL)
REM DISPLAY "CLEND$ ' ";CLEND$
    DECPT$="."
    DECLOC$=INSTR(CLEND$,DECPT$) ! FIND DECIMAL PT
    CLEND%=VAL(DECLOC$) ! CONVERT POSITION OF DEC PT
    IF CLEND%)0 THEN ! IF DEC PT FOUND
      CLEND$=MID$(CLEND$,2,CLEND%+1) ! STRIP OFF CHARS BEYOND 2ND DEC PLACE
    ELSE
      CLEND$=CLEND$+".00" ! ADD 2 DEC PLACES
    END IF
    MAN1$="LENGTH = "+CLEND$
    DISMANUL ! DISPLAY LENGTH ON MANUAL CONTROL DISPLAY
REM DISPLAY "CLEND$ = ";CLEND$
REM SET TIMER 1 FOR 1 SECOND
REM WAIT FOR TIMER 1
END PROCEDURE
```

A31

```
PROCEDURE DISMANUL
  ! THIS PROCEDURE DISPLAYS THE MESSAGE MAN1$ ON THE MANUAL CONTROL STATION
  ! DISPLAY.
  !
  DEFINE MAN$ AS MANUAL
REM  ESC$="\33" ! ESC CHARACTER
REM  TERM$="\02" ! TERMINATOR = STX
REM  M$="m" ! COMMAND TO PROGRAM FUNCTION KEY
  CLR$="                    "
  MAN$=CLR$
  SEND MAN$ ! CLEAR PREVIOUS DISPLAY
     MAN$=MAN1$
     SEND MAN$
REM  SET TIMER 1 FOR 2 SECONDS
REM  WAIT FOR TIMER 1
END PROCEDURE
```

A32

```
PROCEDURE RLEN
  REM THIS PROCEDURE RECORDS ROD LENGTH.  IT ALSO COMPARES THE LENGTH OF THE
  REM FIRST CIGARETTE IN THE SAMPLE TO THE EXPECTED LENGTH.  IF NOT WITHIN
  REM RANGE OF THE EXPECTED LENGTH, AN ERROR IS INDICATED.  5/15/90   WBA
REM  PRINT "MEASURING ROD LENGTH ";TIME$ ! *****
  DEFINE CL$ AS CLEN
REM  GETLEN ! READ CAMERA AND GET LENGTH
REM  CLENDLEN%=LEN(CLEND$)
REM  CLEND$=LEFT$(CLEND$,CLENDLEN%-1) ! STRIP OFF UNWANTED DIGIT
REM  DISPLAY CLEND$
REM  PRINT " MEASURING ROD LEN COMPLETED "; TIME$ ! *****
  IF VAL(CLEND$) ( 124 THEN    ! IF SAMPLE PRESENT
REM PRINT "CHECKING FOR LEN ERROR ";TIME$ ! *****
    IF (RODCHECK%=1) AND (ABS(VAL(CLEND$)-CIGLEN%) ) 3) THEN
      ! IF DIFFERENCE BETWEEN ACTUAL AND EXPECTED LENGTHS ) 3 MM
      RODCHECK%=0 ! CLEAR ROD CHECK FLAG
      DISPLAY
      DISPLAY "MEASURED ROD LENGTH IS NOT WHAT WAS EXPECTED"
      DISPLAY "    ACTUAL ROD LENGTH = ";CLEND$
      DISPLAY "    EXPECTED ROD LENGTH = ";CIGLEN%
      IF ERRSTOP$="T" THEN ! IF STOPPING ON DETECTED ERRORS
        ERRRESP ! GET OPERATOR INSTRUCTIONS FOR WHAT TO DO
      ELSE
        CIGLEN$=STR$(CIGLEN%) ! CONVERT EXPECTED LENGTH TO STRING
        PROB$="ROD LENGTH="+CLEND$+" ; EXPECTED LENGTH="+CIGLEN$ ! TROUBL MESS
        LOGPROB ! LOG IN PROBLEM FILE
      END IF
    END IF
    RODCHECK%=0 ! RESET ROD CHECK FLAG
REM PRINT " LEN ERROR CHECK COMPLETED ";TIME$ ! *****
    IF (RLFLAG = 1) AND (TST1%)0) THEN  ! IF ROD LENGTH REQUIRED
REM   PRINT "DISPLAYING AND SAVING ROD LEN DATA ";TIME$ ! *****
REM   CURSOR (T1%@17)+7,6 ! POSITION CURSOR
      CURSOR (DLINE%@17)+7,6
      DISPLAY CLEND$; ! DISPLAY DATA
      T1%=T1%+1 ! INCR LOOP CNTR
REM   IF T1% = 1 THEN
REM     WRITE CLEND$ TO "CL.DAT" ! PUT DATA IN FILE
REM   ELSE
        APPEND CLEND$ TO "CL.DAT" ! PUT DATA IN FILE
REM   END IF
      CLOSE "CL.DAT"
      TST1% = TST1%-1 ! DEC # OF TEST CTR
REM   PRINT " SAVING ROD LEN DATA COMPLETED ";TIME$ ! *****
    END IF
  END IF
END PROCEDURE
```

A33

```
PROCEDURE CRTDCHK
  ! THIS PROCEDURE IS TO CHECK THE TOTAL RTD INSTRUMENT BEFORE ATTEMPTING TO
  ! INSERT A SAMPLE INTO IT.  IT READS THE METER AND ATTEMPTS TO BLOW OBJECT
  ! OUT IF IT FEELS THAT SOMETHING IS ALREADY IN THE INSTRUMENT.  IT READS THE
  ! METER AGAIN AND INDICATES AN ERROR TO THE OPERATOR IF IT FEELS THAT
  ! SOMETHING IS STILL IN THE INSTRUMENT.   4/26/90   WBA
REM  PRINT "CHECKING IF CRTD INSTR EMPTY ";TIME$ ! ****
  SW2_ON
  READCRTD ! READ CIGARETTE RTD
REM READVENT
  SW2_OFF
  IF (VAL(CR$)>5) THEN ! OR (VAL(D$)>5) THEN ! IF INSTRUMENT NOT EMPTY
    SW3_ON ! ATTEMPT TO BLOW OBJECT OUT
    SET TIMER 1 FOR 2 SECONDS
    WAIT FOR TIMER 1
    SW3_OFF
    FAULT$=""
    REPEAT$="T"
    WHILE REPEAT$ = "T" ! CHECK UNTIL NO REPEAT REQUIRED
      SW2_ON
      READCRTD ! TRY AGAIN
REM   READVENT
      SW2_OFF
      IF (VAL(CR$)>5) THEN ! OR (VAL(D$)>5) THEN ! IF INSTRUMENT STILL NOT
        DISPLAY
        DISPLAY "THERE APPEARS TO BE SOMETHING ALREADY IN THE CIGARETTE RTD ";
        DISPLAY "INSTRUMENT."
        DISPLAY "PLEASE CHECK IT."
        ERRRESP ! GET OPERATOR'S INSTRUCTION
        IF ERRSTOP$="F" THEN ! IF NOT STOPPING ON DETECTED ERRORS
          PROB$="CRTD NOT EMPTY" ! SET TROUBLE MESSAGE
          LOGPROB ! SAVE TROUBLE IN FILE FOR WORKSTATION
          REPEAT$="F" ! SET TO EXIT LOOP
        END IF
      ELSE
        REPEAT$="F" ! SET TO EXIT LOOP
      END IF
    END WHILE
  END IF
REM  PRINT " CRTD INSTR CHECK COMPL ";TIME$ ! *****
END PROCEDURE
```

A34

```
PROCEDURE TOTRTD
  ! THIS PROCEDURE READS TOTAL RTD AND VENTILATION IF REQUIRED, AND DISPLAYS
  ! THE DATA.  1/19/90
  !
REM  CRFLAG=1 ! **** REMOVE AFTER DEBUG
REM  TST2%=1 ! ****
REM  DFLAG=1 ! ****
REM  TST4%=1 ! ****
  SPEED 6
  CRTDLOAD
  IF (CRFLAG=1) AND (TST2%)0) THEN ! IF CRTD TEST REQUIRED
    READCRTD ! GET CRTD DATA
    CURSOR (DLINE%@17)+7,18
    DISPLAY CR$;
    T2%=T2%+1 ! INCR LOOP CNTR
    TST2%=TST2%-1 ! DECR CIG RTD TEST CTR
    APPEND CR$ TO "CRTD.DAT" ! SAVE CIG RTD DATA
    CLOSE "CRTD.DAT"
REM PRINT " SAVE COMPLETED ";TIME$ ! *****
  END IF
  IF (DFLAG=1) AND (TST4%)0) THEN ! IF DILUTION REQUIRED
    READVENT ! READ VENT DATA
    CURSOR (DLINE%@17)+7,28
    DISPLAY D$;
    T4%=T4%+1 ! INCR LOOP CNTR
    TST4%=TST4%-1 ! DEC DIL TEST CTR
    APPEND D$ TO "DIL.DAT" ! SAVE DIL DATA
    CLOSE "DIL.DAT"
REM PRINT " SAVE COMPLETED ";TIME$ ! *****
  END IF
  CLOSE
  SW2_OFF ! DATA TAKEN TURN OFF VALVE
  SPEED 6
  CRTDUNLD ! UNLOAD INSTRUMENT
END PROCEDURE
```

```
PROCEDURE CRTDLOAD
REM  SPEED 6
  SPEED 9
  CRTD3
  CONTINUOUS
    CRTD5
    CRTD2
    CRTD1
  END CONTINUOUS
  SW2_ON  ! TURN ON VALVE TO TAKE RTD DATA
REM  SET TIMER 1 FOR 1 SECOND
REM  WAIT FOR TIMER 1
  OPEN
END PROCEDURE
```

A56

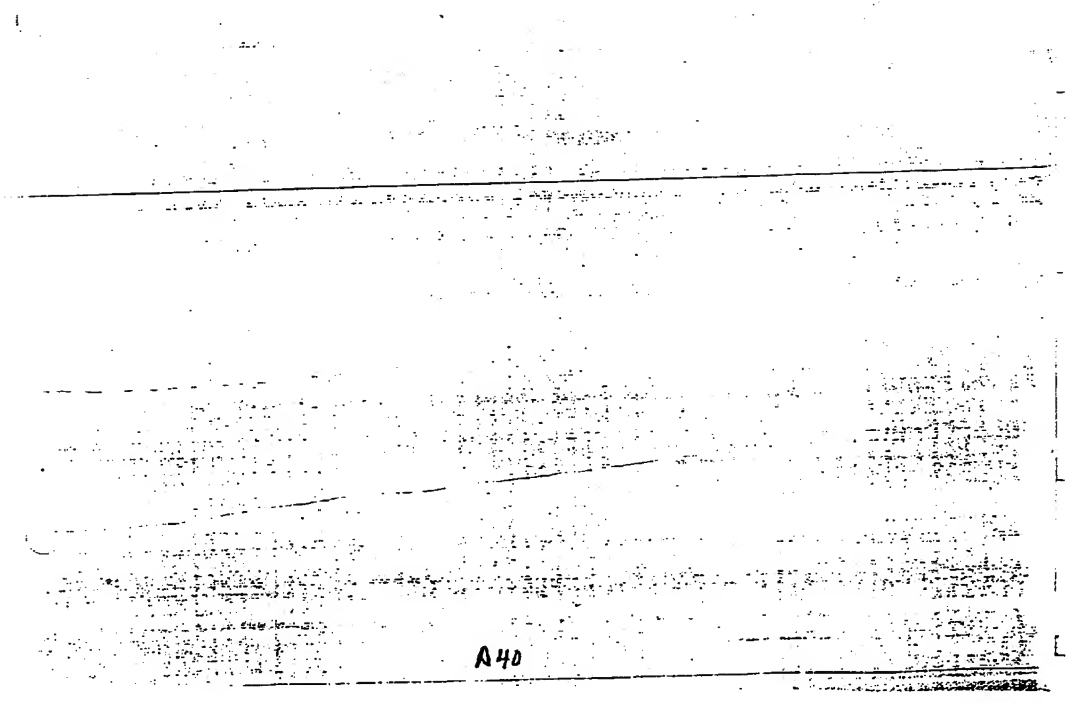
```
PROCEDURE READCRTD
  ! THIS PROCEDURE READS THE CRTD METER DATA. IT SENDS THE 'XS' MESSAGE TO
  ! SEND DATA.  THE PROGRAM WAITS IN A LOOP UNTIL THE DIFFERENCE BETWEEN 2
  ! CONSECUTIVE READINGS IS LESS THAN 2.  IT THEN SAVES THE LAST READING AS
  ' THE DATA.  THE DATA IS FORMATED FOR FUTURE USE.   2/5/90  WBA
    DEFINE CR$ AS CPDI
    DEFINE CRT$ AS CPDI
REM SET TIMER 1 FOR .5 SECONDS
REM WAIT FOR TIMER 1
    DIFF=20 ! PRESET THE DIFFERENCE IN READINGS
    CRL=0
  WHILE DIFF ) 1 ! WAIT UNTIL DIFF IN READINGS ( 1
    GETCRTD
  END WHILE
    CR$=STR$(C) ! CONVERT BACK TO STRING
    CRTDD$=CR$
REM DISPLAY CR$
REM SET TIMER 1 FOR 2 SECONDS
REM WAIT FOR TIMER 1
END PROCEDURE
```

```
PROCEDURE GETCRTD
  ! THIS PROCEDURE READS THE CRTD METER DATA. IT SENDS THE 'XS' MESSAGE TO
  ! SEND DATA.  THE DATA IS FORMATTED FOR FUTURE USE.
    DEFINE CR$ AS CPDI
    DEFINE CRT$ AS CPDI
    CRT$="XS"
    SEND CRT$  ! SEND CODE TO TX DIG RTD DATA
    RECEIVE CR$ ! GET DATA
rem DISPLAY CR$;
    CR$=MID$(CR$,2,6) ! GET RID OF UNWANTED CHARS
    C=VAL(CR$) ! STRIP OFF LEADING ZEROS
REM DISPLAY C;
    DIFF=ABS(C-CRL) ! GET ABSOLUTE DIFF BET NEW AND LAST READINGS
    CRL=C ! SAVE LAST READING
    CR$=STR$(C) ! CONVERT BACK TO STRING
    CRTDD$=CR$
rem DISPLAY CR$
rem SET TIMER 1 FOR 2 SECONDS
rem WAIT FOR TIMER 1
END PROCEDURE
```

A38

```
PROCEDURE READVENT
  ! THIS PROCEDURE READS THE VENTILATION (DILUTION) METER DATA.  IT SENDS THE
  ! 'XS' MESSAGE TO SEND DATA.  THE PROGRAM WAITS IN A LOOP UNTIL THE
  ! DIFFERENCE BETWEEN 2 CONSECUTIVE READINGS IS LESS THAN 2.  IT THEN SAVES
  ! THE LAST READING AS THE DATA, WHICH IS FORMATTED FOR FUTURE USE.

    DEFINE D$ AS DIL ! RECEIVE BUFFER FOR DIL METER
    DEFINE DT$ AS DIL ! TRANSMIT BUFFER
REM SET TIMER 1 FOR .5 SECONDS
REM WAIT FOR TIMER 1
    DT$="XS" ! SEND CODE TO TX DIL DATA
    DIFF=20 ! PRESET THE DIFFERENCE IN READINGS
    CRL=0 ! CLEAR LAST READING
  WHILE DIFF > 2 ! WAIT UNTIL DIFF IN READINGS < 2
    SEND DT$
    RECEIVE D$ ! GET DIL DATA
    D$=MID$(D$,2,6)  ! STRIP OFF UNWANTED CHARS
    C=VAL(D$) ! STRIP OFF LEADING ZEROS
    DIFF=ABS(C-CRL) ! GET ABSOLUTE DIFF BET NEW AND LAST READINGS
    CRL=C
  END WHILE
    D$=STR$(C) ! CONVERT BACK TO STRINGS
    DILD$=D$
REM DISPLAY D$;
END PROCEDURE
```

```
PROCEDURE CRTDUNLD
  CLOSE
  SW2_OFF ! DATA TAKEN TURN OFF VALVE
  SPEED 6
  CONTINUOUS
    CRTD2
    CRTD3
  END CONTINUOUS
END PROCEDURE
```



```
PROCEDURE CIR
  DEFINE C$ AS CIRC
  CIRLOAD ! PUT SAMPLE IN LASERMIKE
  CIRCHK ! SEE IF SAMPLE IN LASERMIKE
  IF SIH%=1 THEN ! IF SAMPLE PRESENT
    C$="300"
    SEND C$ !SEND MESS TO RESET GAUGE
    RECEIVE C$
    C$="303"
    SEND C$ ! RUN LASERMIKE
    RECEIVE C$
    IF CIGLEN% > 85 THEN
      OPEN ! IF CIG > 85, MOVE WHILE READING
      C1
    ELSE
      SET TIMER 1 FOR 1 SECOND
      WAIT FOR TIMER 1
    END IF
    C=10 ! PRESET CIRCUMFERENCE
    WHILE (C < 12) OR (C > 30) ! WAIT UNTIL CIRCUMFERENCE READ
      C$="201"
      SEND C$ ! SEND MESS TO SEND MEASURMENT
      RECEIVE C$ ! GET DATA FROM GAUGE
      C$=RIGHT$(C$,5) !GET RID OF UN WANTED CHARS
      C=VAL(C$) ! CONVERT FROM STRING TO NUMERIC VALUE
REM C=VAL(C$)+.05 ! ROUND VALUE
    END WHILE
REM C$=STR$(C) ! CONVERT BACK TO STRING
REM DECPT$="."
REM DECLOC$=INSTR(C$,DECPT$) ! FIND DEC PT
REM CX=VAL(DECLOC$)
REM IF CX<>0 THEN ! IF DEC PT FOUND
REM C$=MID$(C$,1,CX+1) ! SAVE TO NEAREST .1 MM
REM ELSE ! IF DEC PT NOT FOUND
REM C$=C$+".0" ! ADD DEC PT
REM END IF
    CIRD$=C$
REM CURSOR (T3X@17)+7,35 ! POSITION CURSOR
    CURSOR (DLINEX@17)+7,35
    DISPLAY C$;
    IF VAL(C$)<12 THEN ! IF VALUE BELOW LIMIT
      ALARM_ON
      SET TIMER 1 FOR 1 SECONDS
      WAIT FOR TIMER 1
      ALARM_OFF
      DISPLAY
      DISPLAY "ERROR IN CIRCUMFERENCE READING"
      DISPLAY "CX = ";CX;" C = ";C;" C$ = ";C$
      IF ERRSTOP$="T" ! IF STOPPING ON DETECTED ERRORS
        SUSPEND
      END IF
    END IF
    T3X=T3X+1 ! INCR LOOP CTR
    APPEND CIRD$ TO "CD.DAT" ! STORE CIRCUMFERENCE DATA
    CLOSE "CD.DAT"
    TST3X = TST3X-1 ! DEC # OF TEST CTR
  END IF
  CIRUNLD ! REMOVE SAMPLE FROM LASERMIKE
END PROCEDURE
```

A4)

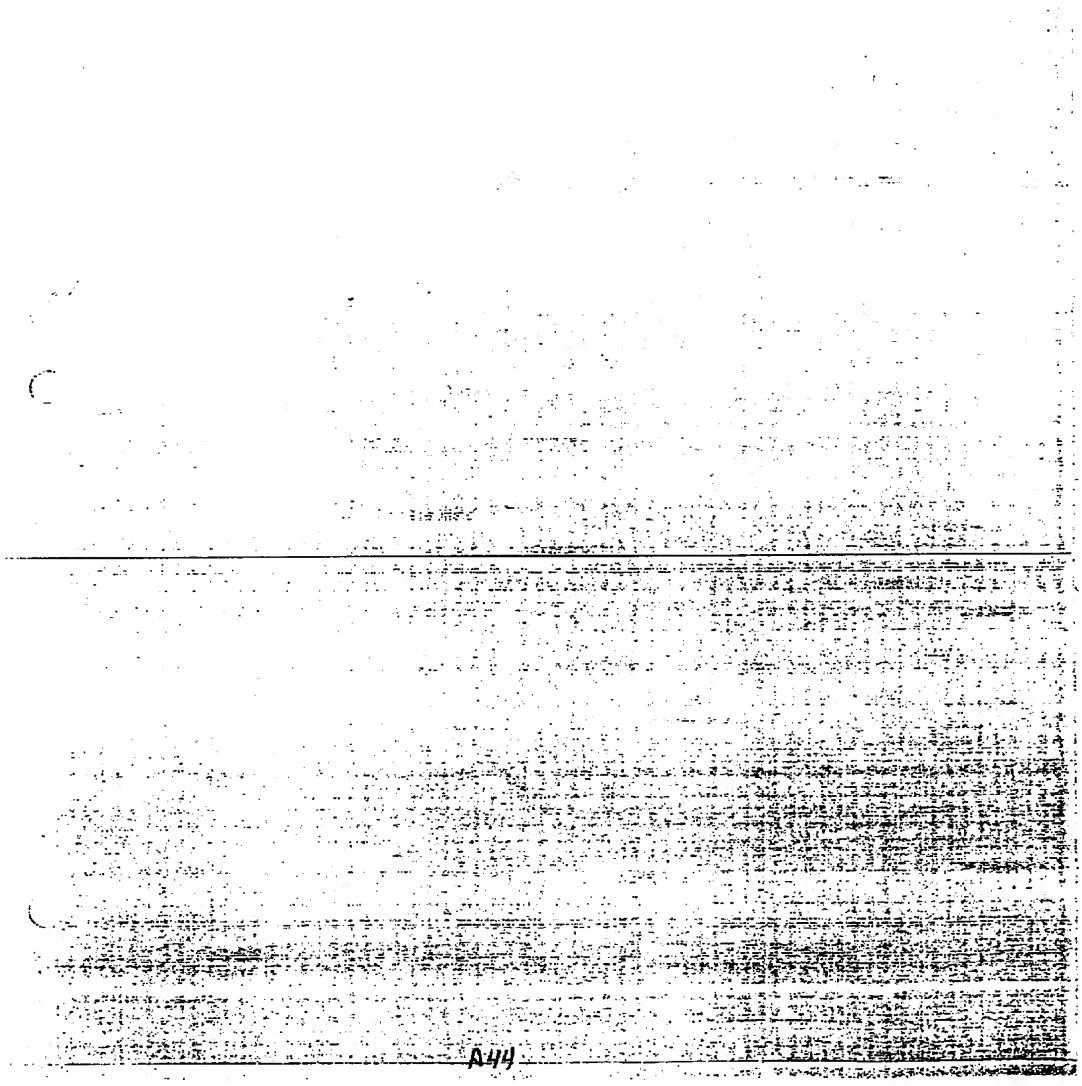
```
PROCEDURE CIRLOAD
  ! THIS PROCEDURE LOADS THE CIGARETTE INTO THE LASER GAGE.  IF THE SAMPLE IS
  ! <= 85 MM LONG, IT IS INSERTED INTO THE INSTRUMENT SO THAT THE LASER BEAM
  ! IS 38 MM FROM THE TOBACCO END OF THE CIGARETTE.  IF > 85 MM, THE SAMPLE
  ' IS PLACED INTO THE INSTRUMENT AND ADJUSTED TO THE PROPER LENGTH.

REM CIGLEN%=120 ! ****
REM  SPEED 6
    SPEED 9
    C4
  IF CIGLEN% < 85 THEN ! IF < 85, DO NOT INSERT AS FAR
    CONTINUOUS
      C3
      C2
      C7
    END CONTINUOUS
  ELSE ! IF >=85, INSERT ALL THE WAY
    CONTINUOUS
      C3
      C2
      C7
      C1
    END CONTINUOUS
  END IF
  OPEN  ! OPEN FINGERS
  IF CIGLEN% > 85 THEN
    C6
    CLOSE
    CONTINUOUS
      C3 ! IF CIG LEN OVER 80(mm) PUSH CIG IN GAUGE
      C2
    END CONTINUOUS
    C3
  END IF
END PROCEDURE
```

A42

```
PROCEDURE CIRCHK
  REM THIS PROCEDURE CHECKS THE LASERMIKE TO SEE IF A SAMPLE IS IN IT. IF A
  REM SAMPLE IS IN THE BEAM, THE SEGMENT ERROR IS TURNED OFF. IF IT IS NOT IN
  REM THE BEAM, THE SEGMENT ERROR IS TURNED ON. THE STATUS OF THE SEGMENT
  REM ERROR IS CHECKED BY READING THE PARAMETERS MESSAGE, WHICH INCLUDES THE
  REM STATUS OF THE SEGMENT ERROR INDICATOR ON THE FRONT PANEL OF THE
  REM LASERMIKE.    3/6/90    WBA
  REM
  DEFINE C$ AS CIRC
  C1$="128"
  WHILE VAL(C1$))127 ! WAIT FOR SEG ERROR TO BE CLEARED
REM  CERR%=0 ! SET FLAG FOR NO CIRC ERROR
    C$="209" ! MESSAGE TO SEND PARAMETERS, INCLUDING LIGHT BAR STATUS
    SEND C$  ! SEND CODE TO TX CIG RTD DATA
    RECEIVE C$
    C1%=LEN(C$) ! GET LENGTH
    IF C1%)3 THEN ! CORRECT RESPONSE WAS RECEIVED
      C1$=RIGHT$(C$,15) ! GET LIGHT BAR STATUS FROM MESSAGE
      C1$=LEFT$(C1$,7) ! GET MESSAGE CONTAINING SEG ERROR STATUS
REM    DISPLAY C1$
      IF VAL(C1$))127 THEN ! SEG ERROR=128
        SIH%=0 ! SET FLAG FOR CIR ERROR
        DISPLAY
        DISPLAY "CIRCUMFERENCE SAMPLE MISSING"
        DISPLAY "PLACE SAMPLE IN LASERMIKE IF NECESSARY"
        ERRRESP ! INDICATE ERROR AND GET RESPONSE
        IF FAULT$="S" THEN ! IF UNATTENDED MODE, SKIP
          C1$="127" ! SET TO EXIT LOOP
          PROB$="CIRCUMFERENCE SAMPLE MISSING" ! TROUBLE MESSAGE TO LOG
          LOGPROB ! LOG PROBLEM IN TROUBLE FILE
        END IF
      ELSE
        SIH%=1 ! SET FLAG FOR SAMPLE IN HAND
      END IF
    END IF
  END WHILE
REM SET TIMER 1 FOR 2 SECOND
REM WAIT FOR TIMER 1
END PROCEDURE
```

A43

```
PROCEDURE CIRUNLD
  CLOSE
  CONTINUOUS
    C2
    C3
    C4
    C5
  END CONTINUOUS
END PROCEDURE
```



```
PROCEDURE FC0
  ! THIS PROCEDURE REPOSITIONS THE CIGARETTE IN THE RIGHT HAND, THEN PLACES IT
  ! IT IN THE FILTER CUTOFF DEVICE AND CUTS OFF THE FILTER TO THE CORRECT
  ! LENGTH
  '
REM  PRINT "REPOSITION OF CIG FOR CUTOFF ";TIME$ ! *****
  CIGREPOS ! REPOSITION THE CIGARETTE AND PICK UP BY FILTER
REM  PRINT " REPOSITION COMPLETED; MOVE TO CUTOFF ";TIME$ ! *****
REM  SPEED 1
REM  SPEED 4
REM SPEED 8
  SPEED 9
  CONTINUOUS
    FC05
    FC04
    FC03
    FC02
  END CONTINUOUS
REM  ADJ%=35-FILLEN% ! FIND DOWN DISTANCE
  ADJ%=35-FILLEN%
  IF ADJ%<17 THEN
    DOWN ADJ% ! MOVE DOWN TO RIGHT DISTANCE TO CUT FILTER
  END IF
  AC1_ON  ! CUT FILTER OFF
  FC03
  AC1_OFF
REM  SW12_ON
REM  SPEED 5
  FC07 ! MOVE NEAR JET
  ADJ%=46-FILLEN%
  IF ADJ%<28 THEN
    DOWN ADJ% ! MOVE TO JET
  END IF
  SW12_ON
REM SET TIMER 1 FOR SECOND
REM
  FC07
  SW12_OFF
  FL3
REM  SW12_OFF
END PROCEDURE
```

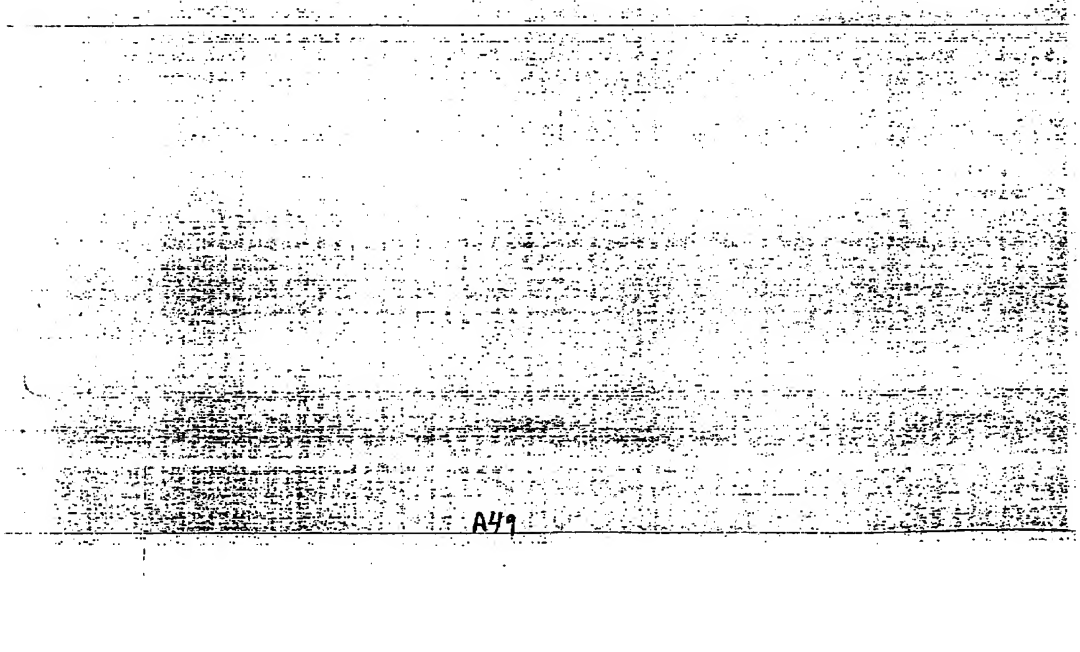
```
PROCEDURE CIGREPOS
REM  SPEED 8
  SPEED 9
  REM SPEED 5
  CIGREP3
  OPEN
  CONTINUOUS
    CIGREP2
    CIGREP1
  END CONTINUOUS
  CLOSE
  CONTINUOUS
    CIGREP4
    CIGREP5
    FC06
  END CONTINUOUS
END PROCEDURE
```

```
PROCEDURE FLEN
  ! THIS IS THE FILTER LENGTH PROCEDURE.  ON THE FIRST TIME THROUGH, IT LOWERS
  ! THE SPINDLE TO SEE THAT THE GAUGE HAS BEEN ZEROED.  IT THEN RAISES THE
  ! SPINDLE AND CHECKS TO SEE THAT IT RAISED.  IT ALSO CHECKS WHEN THE SPINDLE
  ! IS LOWERED TO SEE IF THE GAUGE READS BELOW A CERTAIN VALUE.  IF SO, IT
  ! DOES NOT CLOSE THE HAND, ASSUMING THAT THE SAMPLE WAS DROPPED.  IN ALL
  ! CASES, IF ANY OF THESE TESTS FAIL, THE OPERATOR IS NOTIFIED IF IN THE
  ! ATTENDED MODE, AND A PROBLEM IS LOGGED INTO THE TROUBLE FILE, IF IN THE
  ! UNATTENDED MODE.  IT ALSO CHECKS FOR AN ERROR MESSAGE FROM THE GAUGE
  ! INTERFACE.  5/23/90  WBA
  DEFINE F$ AS FLGAUGE
    IF FLZRO = 0 THEN ! CHK GAUGE ZERO FIRST TIME THRU LOOP
REM     PRINT "CHECKING FLEN ZERO ";TIME$ ! *****
      REPEAT$="T"
      WHILE REPEAT$="T" ! REPEAT UNTIL ERROR DOES NOT EXIST
        AC2_OFF
        SET TIMER 1 FOR 2 SECONDS
        WAIT FOR TIMER 1
        SW1_ON ! TOGGLE SEND DATA SWITCH
        SW1_OFF
        RECEIVE F$ ! RECEIVE DADA FROM GAUGE
          IF (VAL(F$)>.01) OR (VAL(F$)<-.01) THEN
            ALARM_ON
            SET TIMER 1 FOR 1 SECOND
            WAIT FOR TIMER 1
            ALARM_OFF
            DISPLAY
REM         DISPLAY F$
            DISPLAY " MAKE SURE FOOT IS DOWN AND RESET LENGTH GAUGE "
            IF ERRSTOP$="T" THEN ! IF STOPPING ON DETECTED ERRORS
              INPUT " ENTER RETURN AFTER RESETING GAUGE ",Z
              FLZRO=1
            ELSE
              PROB$=" FLEN GAUGE NOT ZEROED" ! CREATE TROUBLE MESSAGE
              LOGPROB ! LOG IN TROUBLE FILE
              REPEAT$="F" ! SET FLAG TO EXIT REPEAT LOOP
            END IF
          ELSE
            FLZRO = 1
            REPEAT$="F" ! SET FLAG TO EXIT REPEAT LOOP
          END IF
        END WHILE
      END IF
      F$="" ! PUT NUL CHAR IN F$
      FAULT$="" ! RESET FAULT RECOVERY STRING
    REPEAT$="T"
    WHILE REPEAT$="T" ! REPEAT UNTIL ERROR DOES NOT EXIST
      AC2_ON ! RAISE FOOT ON GAUGE
      SPEED 9
        SET TIMER 1 FOR 1 SECOND
        WAIT FOR TIMER 1
        READFLEN
        IF VAL(F$)<25 THEN ! IF GAUGE FOOT NOT UP
          AC2_ON ! ATTEMPT TO RAISE FOOT AGAIN
          SET TIMER 1 FOR 1 SECOND
          WAIT FOR TIMER 1
          READFLEN
          IF VAL(F$)<25 THEN ! CHEK FOR FOOT NOT TO BE UP
            ALARM_ON
            SET TIMER 1 FOR 1 SECOND
            WAIT FOR TIMER 1
            ALARM_OFF
            DISPLAY
REM         DISPLAY F$                                    A47
            IF ERRSTOP$ = "T" THEN ! IF STOPPING ON DETECTED ERRORS
```

```
            INPUT    "   CORRECT PROBLEM AND ENTER (CR) TO CONTINUE ";Z
          ELSE
            PROB$="FL[illegible] FOOT DID NOT GO UP" ! SET [illegible]OUBLE STRING
            LOGPROB ! STORE IN TROUBLE FILE
            FAULT$="S" ! SET FLAG TO SKIP THIS FILTER
            REPEAT$="F" ! SET FLAG TO EXIT REPEAT LOOP
          END IF
          DISPLAY
        ELSE
          REPEAT$="F"
        END IF
      ELSE
        REPEAT$="F"
      END IF
    END WHILE
    REPEAT$="T"
    WHILE REPEAT$="T"
        IF ASC(F$)=69 THEN ! IF 'E'RROR
          ALARM_ON
          SET TIMER 1 FOR 1 SECOND
          WAIT FOR TIMER 1
          ALARM_OFF
          DISPLAY
          DISPLAY " ERROR HAS OCCURED ON BH 100 INTERFACE: POWER DOWN ";
          DISPLAY "AND BACK ON "
          IF ERRSTOP$="T" THEN ! IF STOPPING ON DETECTED ERRORS
            INPUT " THEN ENTER ( CR ) TO CONTINUE ";Z
          ELSE
            PROB$="BH100 INTERFACE ERROR" ! SET TROUBLE MESSAGE
            LOGPROB ! SAVE MESSAGE IN TROUBLE FILE
            FAULT$="S" ! SET FLAG TO SKIP THIS FILTER
            REPEAT$="F" ! SET FLAG TO EXIT REPEAT LOOP
          END IF
        ELSE ! IF NOT INTERFACE ERROR
          REPEAT$="F" ! SET FLAG TO EXIT REPEAT LOOP
        END IF
      END WHILE
    IF FAULT$()"S" THEN ! IF NO FAULT DETECTED
      CONTINUOUS
        FL2
        FL1
      END CONTINUOUS
      AC2_OFF ! LOWER FOOT
      SET TIMER 1 FOR 1 SECOND
      WAIT FOR TIMER 1 ! WAIT FOR FOOT TO DROP
      OPEN
      SET TIMER 1 FOR 1 SECOND
      WAIT FOR TIMER 1 ! WAIT FOR READING TO SETTLE
      READFLEN
REM   CURSOR (T5X@17)+7,45
      CURSOR (DLINEX@17)+7,45
      DISPLAY F$;
      IF VAL(F$)>10 THEN ! IF SAMPLE IN HAND
        T5T5X=T5T5X-1 ! DECR SAMPLE CTR
        T5X=T5X+1 ! INCR LOOP CTR
        APPEND FLD$ TO "FL.DAT" ! SAVE FILT LEN DATA
        CLOSE "FL.DAT"
        CLOSE ! CLOSE ONLY IF SAMPLE IN HAND
      ELSE
        PROB$="FLEN SAMPLE NOT PRESENT" ! SET TROUBLE MESSAGE
        LOGPROB ! SAVE MESSAGE IN FILE
        SIHX=0 ! SET FLAG FOR NO SAMPLE IN HAND
      END IF
      AC2_ON
      SET TIMER 1 FOR 1 SECOND
```

A48

```
        WAIT FOR TIMER 1   ! WAIT FOR FOUT TO RAISE
REM WIPE PLATFORM WITH HAND IF SAMPLE DROPPED, TO REMOVE SAMPLE
        CONTINUOUS
          FL2
          FL4
        END CONTINUOUS
      END IF ! NO FAULT DETECTED
END PROCEDURE
```



```
PROCEDURE READFLEN
  REM THIS PROCEDURE READS THE FILTER LENGTH GAUGE DATA.  IT TOGGLES THE
  REM GAUGE INTERFACE TO SEND THE DATA, THEN WAITS TO RECEIVE THE DATA FROM
  REM THE GAUGE.
  REM
    FINE F$ AS FLGAUGE
      SW1_ON
      SW1_OFF ! TOGGLE SEND DATA SWITCH
      RECEIVE F$ ! RECEIVE LENGTH DATA
REM   DISPLAY F$
      LENF%=LEN(F$)-1
      IF LENF%)0 THEN
        F$=LEFT$(F$,LENF%) ! GET RID OF UNWANTED CHARS
      END IF
      IF VAL(F$)=0 THEN ! **** REMOVE AFTER DEBUGGING; LEAVING PLUG IN GAUGE
        CURSOR 23,70
        DISPLAY F$;
      END IF
REM   F=VAL(F$)+.05 ! ROUND VALUE
REM   F$=STR$(F) ! CONVERT BACK
REM   DECPT$="."
REM   DECLOC$=INSTR(F$,DECPT$) ! FIND THE DEC PT
REM   LENF%=VAL(DECLOC$) ! CONVERT LOC OF DEC PT
REM   F$=MID$(F$,1,LENF%+1) ! GET VALUE TO NEAREST TENTH OF MM
      FLD$=F$
REM   CURSOR (T5%@17)+7,45
REM   DISPLAY F$;
REM   SET TIMER 1 FOR .3 SECOND
REM   WAIT FOR TIMER 1  ! WAIT FOR FOOT TO RAISE
END PROCEDURE
```

```
PROCEDURE FRTDCHK
  ! THIS PROCEDURE IS TO CHECK THE FILTER RTD INSTRUMENT BEFORE ATTEMPTING TO
  ! INSERT A SAMPLE INTO IT.  IT READS THE METER AND TRYS TO BLOW THE OBJECT
  ! OUT IF IT FEELS THAT SOMETHING IS ALREADY IN THE INSTRUMENT.  IT DOES THIS
  ! 3 TIMES AND SIGNALS THE OPERATOR IF THERE IS STILL SOMETHING IN THE
    INSTRUMENT, IF IN ATTENDED MODE.  IF UNATTENDED, IT LOGS A MESSAGE INTO
  ! THE TROUBLE FILE FOR TRANSMISSION TO THE WORKSTATION.  4/25/90   WBA
REM  PRINT " CHECK IF FRTD INSTR EMPTY ";TIME$ ! *****
  SW4_ON ! ACTIVATE INSTRUMENT
  SET TIMER 1 FOR 1 SECONDS
  WAIT FOR TIMER 1
  READFRTD ! READ FILTER RTD DATA
REM  SW4_OFF
  IF (VAL(FR$))5) THEN ! IF INSTRUMENT NOT EMPTY
REM    SW5_ON ! ATTEMPT TO BLOW OBJECT OUT OF INSTRUMENT
REM    SET TIMER 1 FOR 1 SECONDS
REM    WAIT FOR TIMER 1
REM    SW5_OFF
REM FRTDUNLD ! ATTEMPT TO REMOVE OBJECT FROM INSTRUMENT
    TRYCTRX=0 ! INITIALIZE ATTEMPT COUNTER
    FAULT$=""
    REPEAT$="T"
    WHILE REPEAT$="T"
      FRTDUNLD ! ATTEMPT TO BLOW OBJECT OUT OF INSTRUMENT
      SW4_ON
      READFRTD ! READ METER AGAIN
      SW4_OFF
      IF (VAL(FR$))5) THEN ! IF INSTRUMENT STILL NOT EMPTY
        TRYCTRX=TRYCTRX+1 ! INCREMENT ATTEMPT COUNTER
        IF TRYCTRX=3 THEN ! IF THIRD ATTEMPT
          DISPLAY
          DISPLAY "THERE APPEARS TO BE SOMETHING ALREADY IN THE FILTER RTD ";
          DISPLAY "INSTRUMENT."
          DISPLAY "PLEASE CHECK IT."
          ERRRESP ! GET OPERATOR'S INSTRUCTION
          IF ERRSTOP$="F" THEN ! IF NOT STOPPING ON DETECTED ERRORS
            PROB$="FRTD NOT EMPTY" ! SET TROUBLE STRING
            LOGPROB ! LOG PROBLEM IN FILE
            REPEAT$="F" ! SET FLAG TO EXIT LOOP
          END IF
        END IF
      ELSE ! IF INSTRUMENT NOT EMPTY
        REPEAT$="F" ! SET TO EXIT LOOP
      END IF
    END WHILE
  END IF
REM  ELSE ! IF INSTRUMENT EMPTY
    SW4_OFF ! RELEASE VACUUM
REM  END IF
REM  PRINT " FRTD INSTR CHECK COMPL ";TIME$ ! *****
END PROCEDURE
```

A-7

```
PROCEDURE FRTD
   FRTDLOAD ! PUT FILTER ON INSTRUMENT
   READFRTD ! GET FIL RTD DATA
REM   PRINT " FRTD DATA RCVD; DISPLAY AND SAVE ";TIME$ ! *****
PRINT CURSOR (T6%@17)+7,56
   CURSOR (DLINE%@17)+7,56
   DISPLAY FR$;
   APPEND FR$ TO "FRTD.DAT" ! SAVE FILT RTD DATA
   CLOSE "FRTD.DAT"
   T6%=T6%+1 ! INCR LOOP CTR
   FRTDUNLD ! REMOVE SAMPLE
   TST6%=TST6%-1    ! DEC LOOP CNTR FOR TEST
REM   PRINT " FRTD SAMPLE REMOVAL COMPL ";TIME$ ! *****
END PROCEDURE
```

A52

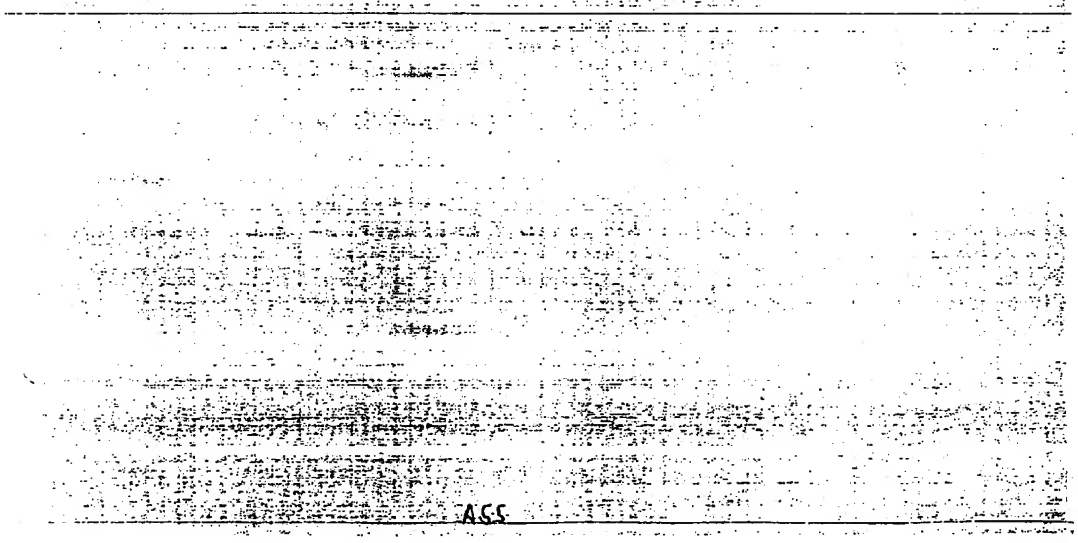
```
PROCEDURE FRTDLOAD
REM SPEED 7
   SPEED 9
   FRTD3
   CONTINUOUS
   FRTD4
REM  FRTD3
     FRTD2
     FRTD1
   END CONTINUOUS
   SW4_ON
   SET TIMER 1 FOR 1 SECONDS
   WAIT FOR TIMER 1  ! WAIT FOR VAC TO HOLD FILTER
   OPEN
   SW4_OFF    ! LET FILTER GO IN AGAINST PLUG
REM FRTD2
REM CLOSE
   FRTD1
    FRTD6 ! ****
    FRTD4 ! *****
REM CLOSE
REM SET TIMER 1 FOR 1 SECOND
REM WAIT FOR TIMER 1
   SW4_ON
   FRTD5
END PROCEDURE
```

A53

```
PROCEDURE READFRTD
  ! THIS PROCEDURE ACTIVATES THE FILTER RTD INSTRUMENT AND READS THE METER.
  ! IT SENDS THE 'XS' MESSAGE TO SEND DATA.  THE PROGRAM WAITS IN A LOOP UNTIL
  ! THE DIFFERENCE BETWEEN 2 CONSECUTIVE READINGS IS LESS THAN 2.  IT THEN
  ! SAVES THE LAST READING AS THE DATA, WHICH IS FORMATTED FOR FUTURE USE.

  DEFINE FR$ AS FPDI ! FRTD RECEIVE BUFFER
  DEFINE FRT$ AS FPDI ! FRTD TRANSMIT BUFFER
REM SET TIMER 1 FOR .5 SECONDS
REM WAIT FOR TIMER 1
  FRT$="XS"
  DIFF=20 ! PRESET THE DIFFERENCE IN READINGS
  CRL=0 ! CLEAR LAST READING
  WHILE DIFF ) 1 ! WAIT UNTIL DIFF IN READINGS ( 1
    SEND FRT$  ! SEND CODE TO TX RTD DATA
    RECEIVE FR$
rem DISPLAY FR$;
    FR$=MID$(FR$,2,6)
REM DISPLAY FR$
    F=VAL(FR$) ! STRIP LEADING ZEROS
REM IF (F=0) OR (F)0) THEN ! IF POSITIVE
      DIFF=ABS(F-CRL) ! GET ABSOLUTE DIFF BET NEW AND LAST READINGS
      CRL=F ! SAVE LAST READING
REM END IF
  END WHILE
  FR$=STR$(F) ! CONVERT BACK TO STRING
rem DISPLAY FR$
rem SET TIMER 1 FOR 2 SECOND
rem WAIT FOR TIMER 1
END PROCEDURE
```

A54

```
PROCEDURE FRTDUNLD
   SW4_OFF ! RELEASE FIL
   SW5_ON ! ACTIVATE EJECTOR TO BLOW FILTER OUT OF TUBE
   SET TIMER 1 FOR .9 SECONDS
   WAIT FOR TIMER 1
   SW5_OFF
END PROCEDURE
```



```
PROCEDURE DAT
  REM PROCEDURE TO TRANSFER DATA FOR DATABASE USE. THE DATA IS FORMATTED
  REM INTO 1 FILE HAVING NAME XXXXXXXX.DAT, WHERE XXXXXXXX IS THE ACTUAL
  REM BARCODE OF THE SAMPLE. THE DATA IS THEN COPIED TO \LINK\WORK DIRECTORY
  REM FOR ARCHIVING. THE STATUS OF THE NETWORK IS CHECKED, AND IF OPERATIONAL,
  REM THE DATA IS TRANSMITTED TO G: DRIVE FOR RETRIEVAL BY THE WORKSTATION.
  REM IF THE NETWORK IS NOT OPERATIONAL, THE DATA IS SAVED IN \LINK\WORK\TMP
  REM FOR TEMPORARY STORAGE.    1/15/90    WBA
  REM
  WORKDR$="\LINK\WORK\" ! DRIVE FOR ARCHIVING OF DATA
  WSDDR$="G:" ! WORKSTSTION DATA DRIVE
  CLEAR
  DISPLAY
  DISPLAY
  DISPLAY "          TRANSFERRING DATA FOR BARCODE "; BCODE$
REM  BCODE$="11223344" ! ****** REMOVE AFTER TEST
REM  RLFLAG=1 ! ****
REM   CRFLAG=1 ! ****
REM  CFLAG=1 ! ****
REM  DFLAG=1 ! ****
REM  FLFLAG=1 ! ****
REM  FRFLAG=1 ! ****
REM  LINK$="UP" ! ****
  BARCODE.DAT$=WORKDR$+BCODE$+".DAT"
  D$="BC "+BCODE$
  WRITE D$ TO BARCODE.DAT$ ! SAVE BARCODE IN DATA FILE
  D$="DATE "+DATE$  ! GET DATE AND STORE IN FILE
  WRITE D$ TO BARCODE.DAT$
  T$="TIME "+TIME$  ! GET TIME AND STORE IN FILE
  WRITE T$ TO BARCODE.DAT$
  IF RLFLAG=1 THEN ! IF RODLENGTH TESTED
    FOR I% = 1 TO 200
      READ DATA$ FROM "CL.DAT"
      WRITE DATA$ TO BARCODE.DAT$
      IF EOF("CL.DAT") = 1 THEN
        I%=200
      END IF
    NEXT I%
    CLOSE "CL.DAT"
  END IF
  IF CRFLAG = 1 THEN ! IF CIGARETTE RTD TESTED
    FOR I% = 1 TO 200
      READ DATA$ FROM "CRTD.DAT"
      WRITE DATA$ TO BARCODE.DAT$
      IF EOF("CRTD.DAT") = 1 THEN
        I%=200
      END IF
    NEXT I%
    CLOSE "CRTD.DAT"
  END IF
  IF CFLAG = 1 THEN ! IF CIRCUMFERENCE TESTED
    FOR I% = 1 TO 200
      READ DATA$ FROM "CD.DAT"
      WRITE DATA$ TO BARCODE.DAT$
      IF EOF("CD.DAT") = 1 THEN
        I%=200
      END IF
    NEXT I%
    CLOSE "CD.DAT"
  END IF
  IF DFLAG = 1 THEN ! IF DILUTION TESTED
    FOR I% = 1 TO 200
      READ DATA$ FROM "DIL.DAT"
      WRITE DATA$ TO BARCODE.DAT$
      IF EOF("DIL.DAT") = 1 THEN
        I% =200
```

AS6

```
        END IF
      NEXT I%
      CLOSE "DIL.DAT"
    END IF
    IF FLFLAG = 1 THEN ! IF FILTER LENGTH TESTED
      FOR I% = 1 TO 200
        READ DATA$ FROM "FL.DAT"
        WRITE DATA$ TO BARCODE.DAT$
        IF EOF("FL.DAT") = 1 THEN
          I%=200
        END IF
      NEXT I%
      CLOSE "FL.DAT"
    END IF
    IF FRFLAG = 1 THEN ! IF FILTER RTD TESTED
      FOR I% = 1 TO 200
       READ DATA$ FROM "FRTD.DAT"
       WRITE DATA$ TO BARCODE.DAT$
       IF EOF("FRTD.DAT") = 1 THEN
         I%=200
       END IF
      NEXT I%
      CLOSE "FRTD.DAT"
    END IF
    CLOSE BARCODE.DAT$ ! *****
    CMD1$="COPY "+BARCODE.DAT$ ! INITIALIZE CMD TO TRANSFER DATA
REM CMD$=CMD1$+" \LINK\WORK" ! CMD TO TRANSFER TO ARCHIVE DIRECTORY
REM WRITE CMD$ TO "TRANSFER.BAT" ! SAVE CMD
  IF LINK$<>"DOWN" THEN ! IF NETWORK NOT DOWN
    CHECKLNK ! SEE IF NETWORK STILL ACTIVE
  END IF
  IF LINK$="UP" THEN ! IF NETWORK STILL ACTIVE
    CMD$="COMMAND /C COPYDATA "+WORKDR$+","+BCODE$+".DAT"+","+WSDDR$
    REM COPY TO SERVER
  ELSE               ! IF NETWORK NOT ACTIVE
    CMD$=CMD1$+" \LINK\WORK\TMP" ! COPY TO TEMPORARY DIRECTORY
  END IF
  WRITE CMD$ TO "TRANSFER.BAT"
  CPYPROB ! PREPARE TO COPY PROBLEM FILE
  CLOSE "TRANSFER.BAT"
  DOS TRANSFER.BAT ! EXECUTE TRANSFER OF DATA
REM PRINT
REM PRINT BARCODE.DAT$ ! PRINT BARCODE OF DATA
REM PRINT
REM CMD$="COPY \PERL\"+BARCODE.DAT$+" LPT1:" ! ***** COPY DATA TO PRINTER
REM WRITE CMD$ TO "TRANSFER.BAT" ! *****
REM CLOSE "TRANSFER.BAT"
REM DOS TRANSFER ! *****
  I%=0
  DISPLAY "          TRANSFER OF DATA COMPLETED."
  DISPLAY
END PROCEDURE
```

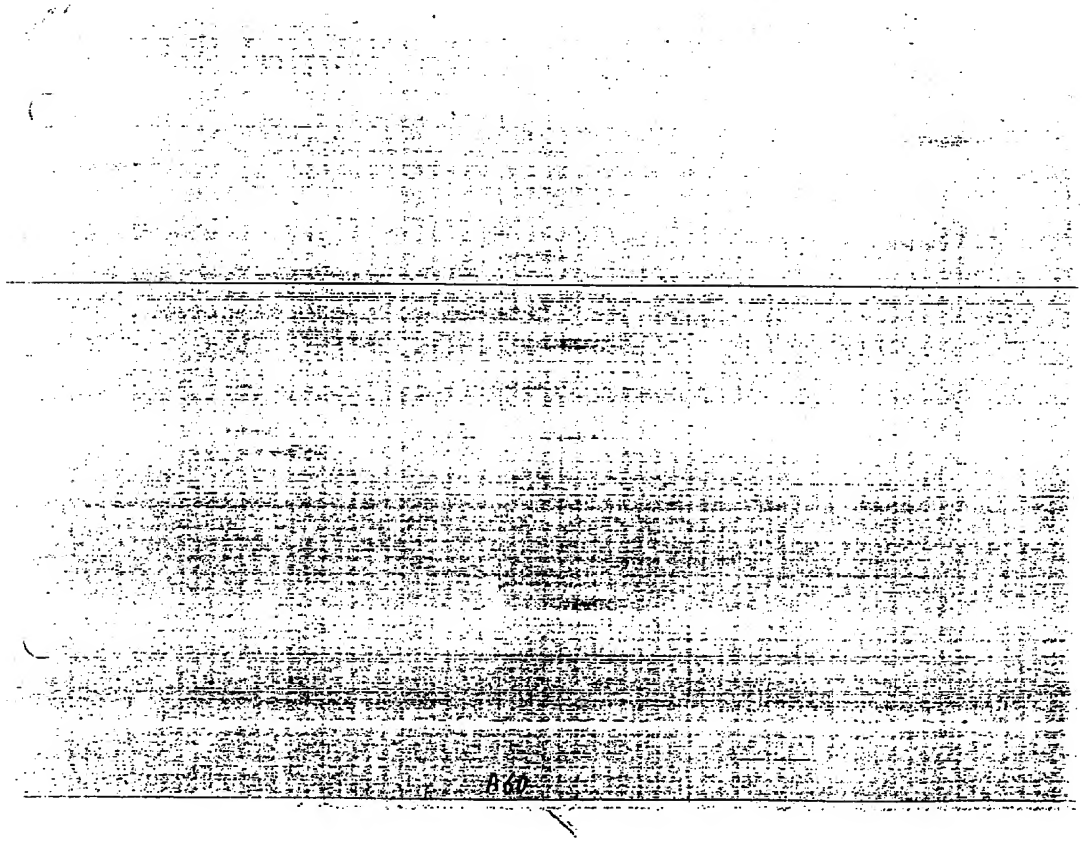
A57

```
: COPYDATA.BAT
: TO COPY DATA FILE FROM WORKSTATION TO WORKSTATION
: IT ATTEMPTS TO COPY FILE, THEN CHECKS TO SEE IF IT EXISTS
: IN G:. IF NOT IT ATTEMPTS TO RECOPY. IF STILL NOT SUCCESSFUL,
: IT COPYS THE FILE TO TMP DIRECTORY FOR LATER COPYING. 5/8/93 WSH
:
rem echo off
COPY %1%2 %3
IF EXIST %3%2 GOTO FINISH
copy %1%2 %3
if EXIST %3%2 GOTO FINISH
COPY \LINK\WORK\%2 \LINK\WORK\TMP
:finish
```

```
PROCEDURE PCHECK
  REM THIS IS THE PAUSE CHECK PROCEDURE.
  REM
  R$=READKEY$ ! SEE IF KEY ENTERED
  IF R$()"" THEN ! IF KEY ENTERED
    WHILE R$()"" ! CLEAR KEYBOARD BUFFER
      R1$=R$ ! SAVE LAST KEY INPUT
      DISPLAY R$;
      R$=READKEY$
    END WHILE
    IF R1$="P" THEN ! IF PAUSE KEY ENTERED
      ERRMODE ! ALLOW ERROR MODE TO BE CHANGED, IF NEEDED
    END IF
    DISPLAY
  END IF
END PROCEDURE
```

A59

```
PROCEDURE ABORTRUN
  REM THIS PROCEDURE ABORTS TESTING OF SAMPLES.  IT ASSUMES THE ROBOT IS CLEAR
  REM OF THE INSTRUMENTS.  IT MOVES TO THE NEXT POSITION, BEFORE LEAVING PERL
  REM AND RETURNING TO THE SYSTEM LEVEL.  4/25/90  WBA
  REM
REM  PROB$="RUN ABORTED" ! SET TROUBLE MESSAGE
REM  LOGPROB ! STORE MESSAGE IN TROUBLE FILE
  NEST1
  SYSTEM
END PROCEDURE
```



```
PROCEDURE CPYPROB
  REM THIS PROCEDURE COP  3 THE TROUBLE FILE, IF ONE   ISTS TO THE ARCHIVE
  REM DRIVE AND TO THE WORKSTATION.    3/30/93   WBA
  LOGDR$="\LINK\LOG\" ! ARCHIVE LOG DRIVE
  WSLDR$="H:" ! WORKSTATION LOG DRIVE
  IF PROBCTR%>0 THEN ! IF OPERATIONAL PROBLEM DETECTED
    CMD1$="COPY TROUBLE.DAT "
    TCODE$=BCODE$+".TBL" ! FORM NAME OF TROUBLE FILE
    CMD$=CMD1$+LOGDR$+TCODE$ ! COMMAND TO COPY TO ARCHIVE DRIVE
    WRITE CMD$ TO "TRANSFER.BAT"
    IF LINK$="UP" THEN ! IF NETWORK ACTIVE
      CMD$="COMMAND /C COPYDATA "+LOGDR$+","+TCODE$+","+WSLDR$
    ELSE
      CMD$=CMD1$+WORKDR$+"TMP\"+TCODE$ ! COPY TO TMP STORAGE DIRECTORY
    END IF
    WRITE CMD$ TO "TRANSFER.BAT" ! WRITE COMMAND
  END IF
END PROCEDURE
```

A61

```
PROCEDURE CLRHOPR
  ! THIS PROCEDURE CLEARS SAMPLES FROM THE FEED HOPPER AT THE END OF A RUN,
  ! IF SAMPLES HAVE BEEN LEFT OVER.  THE LENGTH CAMERA IS USED TO DETECT
  ! THE PRESENCE OF A SAMPLE.  THE SAMPLE IS REMOVED AND DROPPED ON THE TABLE.
  ' 2/9/90   WBA

  SPEED 9
  OPEN
  FAULT$=""
REM  PRINT "FEEDIN SAMPLE ";TIME$ ! *****
  GETLEN ! SEE IF SAMPLE ALREADY THERE
  IF VAL(CLEND$) < 77 THEN ! IF SAMPLE NOT THERE
    FEEDSAMP ! FEED SAMPLE OUT OF HOPPER
  END IF
  GETLEN ! SE IF SAMPLE THERE
  WHILE VAL(CLEND$) > 77 ! WHILE SAMPLES ARE PRESENT
    HOP4
    HOP3
    HOP1
    CLOSE
    HOP3
    HOP4
    OPEN
    FEEDSAMP ! TRY AGAIN TO FEED SAMPLE
    SET TIMER 1 FOR 2 SECONDS
    WAIT FOR TIMER 1
    GETLEN ! SEE IF SAMPLE THERE
  END WHILE
REM PRINT " PICKUP COMPLETED ";TIME$ ! *****
END PROCEDURE
```

A62

Claims

1. Apparatus (10) for measuring a physical characteristic of a plurality of smoking articles (20), comprising:
means (503) for gripping and releasing a smoking article;
means (503) for maneuvring a gripped smoking article within a range of motion;
means for receiving one of the said plurality of smoking articles at a first location within the said range of motion;
means (200)(600)(700)(800)(850) for measuring a physical characteristic of a smoking article or a component (450) of a smoking article, the measuring means being at a second location within the said range of motion; and
means (1000) for controlling the gripping and releasing means and the maneuvring means to grip the smoking article or component at the first location and to maneuver the smoking article or component to the measuring means so that the physical characteristic of the one smoking article can be measured.

2. Apparatus (10) according to claim 1, in which the controlling means (1000) is a microprocessor which controls the gripping and releasing means (503) to release the smoking article (20) or component (450) at the measuring means (200)(600)(700) (800)(850) so that the physical characteristic can be measured and to grip the smoking article or component at the measuring means following the measurement.

3. Apparatus (10) according to claim 1 or 2, in which the gripping and releasing means and the maneuvering means comprise a robot (503) having a first (510) and a second (520) member, the first and second members being movable in opposition for gripping therebetween a smoking article (20) or component (450).

4. Apparatus (10) according to any preceding claim, in which the measuring means (200)(600)(700) comprises first means for measuring a first physical characteristic of a smoking article (20) located at the second location and second means for measuring a second physical characteristic of a smoking article the second measuring means being located at a third location within the said range of motion, and in which the controlling means (1000) controls the gripping and releasing means (503), and the maneuvering means (503) to grip the smoking article at the first location and to maneuver the smoking article to one of the first and second measuring means whereby one of the first and second physical characteristics can be measured.

5. Apparatus (10) according to claim 4, in which the controlling means (1000) controls the gripping and releasing means (503) and the maneuvering means (503) to maneuver the smoking article from the said one of the first and second measuring means (200)(600)(700) to the other of the first and second measuring means whereby the other of the first and second physical characteristics can be measured.

6. Apparatus (10) according to any preceding claim in which the measuring means (200)(600)(700) comprises more than one means for measuring more than one selected physical characteristic of a smoking article in which each said means is located at a different location within the said range of motion, the means being means (600) for measuring circumference, means (700) for measuring ventilation, means (700) for measuring pressure drop or means (200) for measuring length, and in which the controlling means (1000) controls the gripping and releasing means (503) and the maneuvering means (503) to maneuver one smoking article to one or more of the measuring means.

7. Apparatus (10) accroding to claim 4, 5 or 6 in which the controlling means (1000) comprises a means for providing a test sequence identifying one or more physical characteristics of the smoking article (20) to be measured, in which the controlling means is responsive to the test sequence and controls the gripping and releasing means (503) and the maneuvering means (503) to maneuver the gripped smoking article or component (450) to one or more of the measuring means (200)(600)(700)(800)(850) so that the one or more identified physical characteristics can be measured.

8. Apparatus (10) according to claim 7 in which the test sequence identifies the order in which the measurements of each smoking article (20) are to be made.

9. Apparatus (10) according to claim 7 or 8, in which the test sequence identifies the order in which the measurements of each smoking article (20) in the plurality of smoking articles are to be made.

10. Apparatus (10) according to any preceding claim further comprising:

means (300) for severing a component (450) of the smoking article (20) from the smoking article, the severing means being within the said range of motion;

means (800)(850) for measuring a physical characteristic of a smoking article component, the measuring means being within the said range of motion; and

means (1000) for controlling the gripping and releasing means (503) and the maneuvering means (503) to grip the smoking article and maneuver the one smoking article to the severing means, and to maneuver the smoking article component to the measuring means so that the physical characteristic of the smoking article component can be measured.

11. Apparatus (10) according to claim 10 in which the measuring means comprises a first measuring means (800) for measuring a first physical characteristic of a smoking article component (450) and a second means (850) for measuring a second physical characteristic of a smoking article component, and in which the controlling means (1000) controls the gripping and releasing means (503) and the maneuvering means (503) to grip and maneuver the smoking article component to one of the first and second measuring means whereby one of the first and second physical characteristics can be measured.

12. Apparatus (10) according to claim 11 in which the controlling means (1000) controls the gripping and releasing means (503) and the maneuvering means (503) to maneuver the smoking article component (450) from the one of the first and second measuring means (800)(850) to the other of the first and second measuring means whereby the other of the first and second physical characteristics of the smoking article component can be measured.

13. Apparatus (10) according to claim 11 or 12, in which the first and second measuring means are means (800) for measuring pressure drop and means (850) for measuring length.

14. Apparatus (10) according to any of claims 10 to 13 in which the controlling means (1000) comprises a means for providing a test sequence identifying one or more physical characteristics of the smoking article component (450) to be measured, and in which the controlling means is responsive to the provided test sequence and controls the gripping and releasing means (503) and the maneuevering means (503) to maneuver the gripped smoking article component to measuring means (800)(850) so that the one or both identified physical characteristics of the smoking article component can be measured.

15. Apparatus (10) according to claim 14, in which the test sequence identifies the order in which the measurements of the smoking article component (450) are to be made.

16. Apparatus (10) according to claim 14 or 15 in which the test sequence identifies the order in which the measurements of each smoking article component (450) of the plurality of smoking articles (20) are to be made.

17. Apparatus (10) according to any of claims 10 to 16, in which the controlling means (1000) controls the gripping and releasing means (503) and the maneuvering means (503) to grip one smoking article (20) to maneuver the smoking article to a measuring means (200)(600(700) so that a first physical characteristic of the smoking article can be measured, and then to the severing means (300), thereby to sever a component (450) from the smoking article, and to maneuver the smoking article component to another measuring means (800)(850) so that a physical characteristic of the smoking article component can be measured.

18. Apparatus (10) according to claim 17, in which the measuring means comprise more than one means (800)(850) for measuring more than one physical characteristic of a smoking article component (450) at more than one location within the said range of motion, and more than one means (200)(600)(700) for measuring more than one physical characteristic of a smoking article (20) at more than one location within the said range of motion, and the controlling means (1000) comprises a means for providing a test sequence identifying one or more physical characteristics of the smoking article (20) and one or more physical characteristics of the smoking article component (450) to be measured, in which the controlling means is responsive to the provided test sequence and controls the gripping and releasing means (503) and the maneuvering means (503) to maneuver the gripped smoking article to one or more of the measuring means for the smoking article, and the severing means (300) and one or more identified physical characteristics of the smoking article and the smoking article component can be measured.

19. Apparatus (10) according to claim 18, in which the test sequence identifies the order in which the meas-

urements of the smoking article (20) and the smoking article component (450) are to be made such that the physical characteristics of the smoking article are obtained prior to the physical characteristics of the smoking article component.

20. Apparatus (10) according to claim 18 or 19, in which the test sequence identifies the order in which the measurements of each smoking article (20) and smoking article component (450) of the plurality of smoking articles are to be made such that the physical characteristics of each smoking article are obtained prior to the physical characteristics of the smoking article component.

21. Apparatus (10) according to any of claims 10 to 20 further comprising a further means (900) for receiving a smoking article (20) at a location within the said range of motion in which the controlling means (1000) controls the gripping and releasing means (503) and the maneuvering means (503) to release the smoking article onto the said further receiving means and then to grip the smoking article by its component (450) on the said further receiving means, to maneuver the smoking article to the severing means (300), and to grip the smoking article component during the severing process.

22. Apparatus (10) according to any of claims 10 to 21, in which the smoking article component is a filter rod (450) of a cigarette (20), the apparatus further comprising means (400) for deshredding the severed filter component of a cigarette, and in which the controlling means (1000) controls the gripping and releasing means (503) and the maneuvering means (503) to maneuver a severed filter to the deshredding means following the severing operation.

23. A method for measuring a physical characteristic of a plurality of smoking articles in a test station having a means for gripping and releasing a smoking article, means for maneuvering a gripped smoking article within a range of motion, means for receiving one of a plurality of smoking articles at a first location within the range of motion, means for measuring a physical characteristic of a smoking article, the measuring means being at a second location within the range of motion; and microprocessor means for controlling the gripping and releasing means and the maneuvering means, comprising:

providing a plurality of smoking articles;
feeding one smoking article to the receiving means;
gripping the fed smoking article at the receiving means;
maneuvering the gripped smoking article to the measuring means; and
measuring the physical characteristice of the smoking article.

24. A method according to claim 23 further comprising releasing the smoking article at the measuring means so that the physical characteristic can be measured and gripping the smoking article at the first measuring means following the measurement.

25. A method according to claim 23 or 24, in which the gripping and releasing means and the maneuvering means further comprise a robot having a first member and a second member being movable in opposition, and gripping and releasing the smoking article further comprises moving the first and second members together for gripping a smoking article and moving the first and second members apart to release the smoking article.

26. A method according to claims 23, 24 or 25, in which the test station includes more than one means for measuring more than one physical characteristic of a smoking article and in which each means is located at a different location within the said range of motion, the means being means for measuring circumference, means for measuring ventilation and pressure drop or means for measuring length, the method further comprising:

providing a test sequence identifying one or more physical characteristics of the smoking article to be measured; and

gripping and maneuvering the smoking article to one or more of the measuring means in response to the provided test sequence so that the one or more identified physical characteristics can be measured.

27. A method according to claim 26, in which providing the test sequence comprises identifying the order in which the measurements of the smoking article are to be made.

28. A method according to claim 26 or 27, in which providing the test sequence further comprises identifying the order in which the measurements of each smoking article in the plurality of smoking articles are to be

made.

29. A method for measuring a physical characteristic of a component of a plurality of smoking articles in a test station having means for gripping and releasing a smoking article, means for maneuvering a gripped smoking article within a range of motion, means for receiving one of said plurality of smoking articles at a first location within the range of motion, means for severing the component of a smoking article from the smoking article, the severing means being located at a second location within the range of motion, means for measuring a physical characteristic of a smoking article component, the measuring means being at a third location within the range of motion, and microprocessor means for controlling the gripping and releasing means and the maneuvering means, comprising:
providing a plurality of smoking articles;
feeding one smoking article to the receiving means;
gripping the one fed smoking article by its component;
maneuvering the gripped smoking article to the severing means;
severing the smoking article component from the one smoking article;
maneuvering the one smoking article component to the measuring means; and
measuring the physical characteristic of the one smoking article.

30. A method according to claim 29 further comprising releasing the smoking article component at the measuring means so that the physical characteristic of the one smoking article component can be measured and gripping the smoking article component at the measuring means following the measurement.

31. A method according to claim 29 or 30, in which the gripping and releasing means and the maneuvering means further comprise a robot having a first member and a second member movable in opposition and wherein gripping the one smoking article or one smoking article component further comprises moving the first and second members together and releasing the one smoking article component further comprises moving the first and second members apart.

32. A method according to claim 29, 30 or 31, in which the measuring means comprises one or more means for measuring more than one or more physical characteristic of a smoking article component the means being means for measuring pressure drop and means for measuring length, and one or more means for measuring one or more physical characteristics of a smoking article, each measuring means being located at a different location within the said range of motion, the method further comprising:
providing a test sequence identifying one or more of the physical characteristics of the smoking article and the smoking article component to be measured; and
gripping and releasing and maneuvering the smoking article to one or more of the measuring means and the severing station in response to the identified sequence so that the one or more of the identified physical characteristics of the smoking article and the smoking article component can be measured.

33. A method according to claim 32, in which providing the test sequence further comprises identifying the order in which the measurements of the smoking article and the smoking article component are to be made.

34. A method according to claim 32 or 33, in which providing the test sequence further comprises identifying the order in which the measurements of each smoking article and smoking article component of the plurality of smoking articles are to be made.

35. A method according to claim 32, 33 or 34, in which the test station includes a further means for receiving a smoking article at a location within the said range of motion and in which maneuvering the gripped smoking article to the severing means further comprises:
maneuvering the gripped article to the said further receiving means;
releasing the smoking article on the said further receiving means;
gripping the smoking article component while the smoking article is on the said further receiving means; and
maneuvering the smoking article to the severing means so that the gripping means grips the smoking article component during the severing process.

36. A method according to claim 35, in which the smoking article and its component further comprise a cigarette having a tobacco-containing rod and a filter, the method further comprising:
maneuvering the gripped filter severed from the cigarette to a means for deshredding the filter of

any tobacco prior to measuring the physical characteristic of the filter, the deshredding means being at a location within the said range of motion.

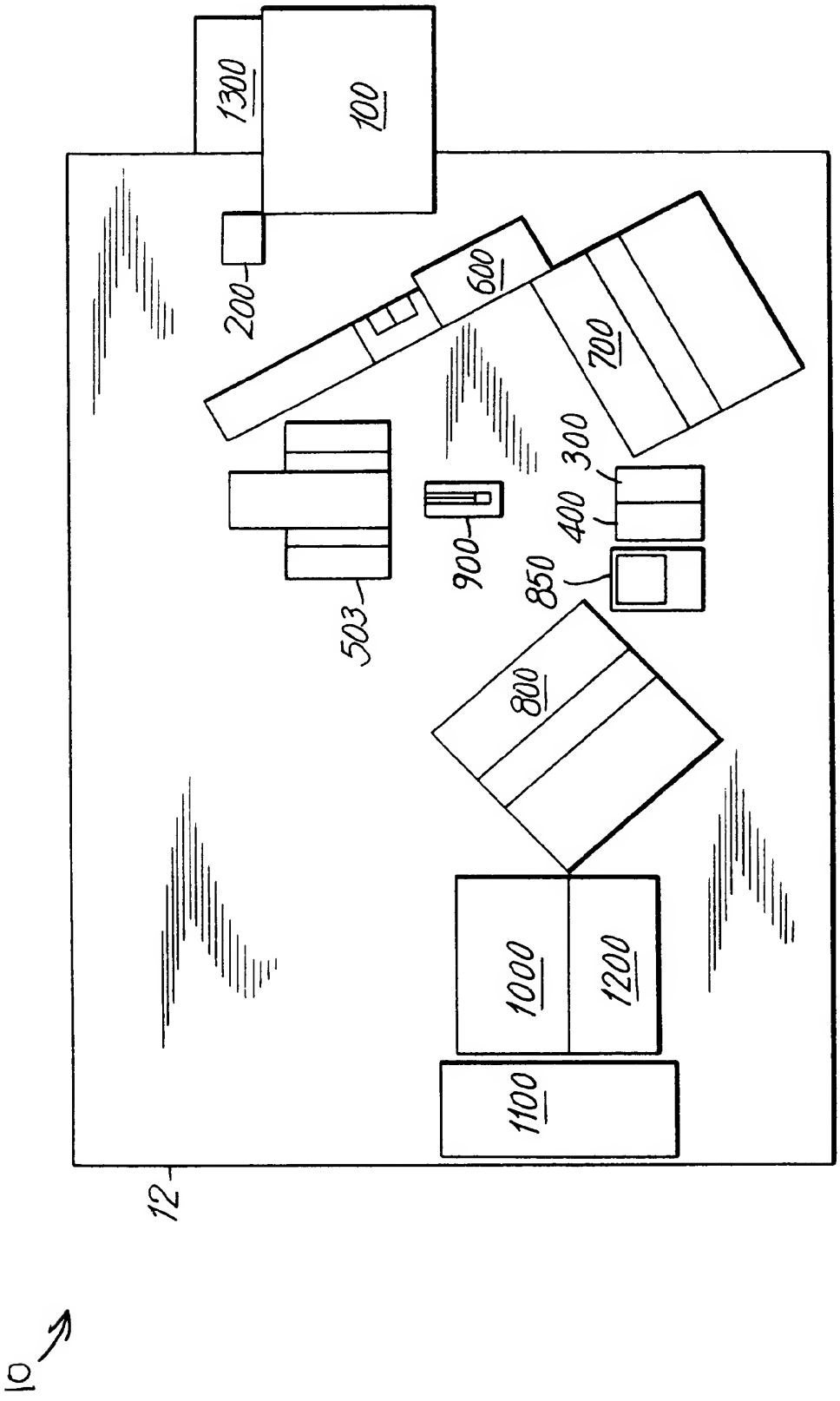

1300
100
200
600
700
300
400
850
900
503
800
1000
1200
1100
12
10

FIG. 1

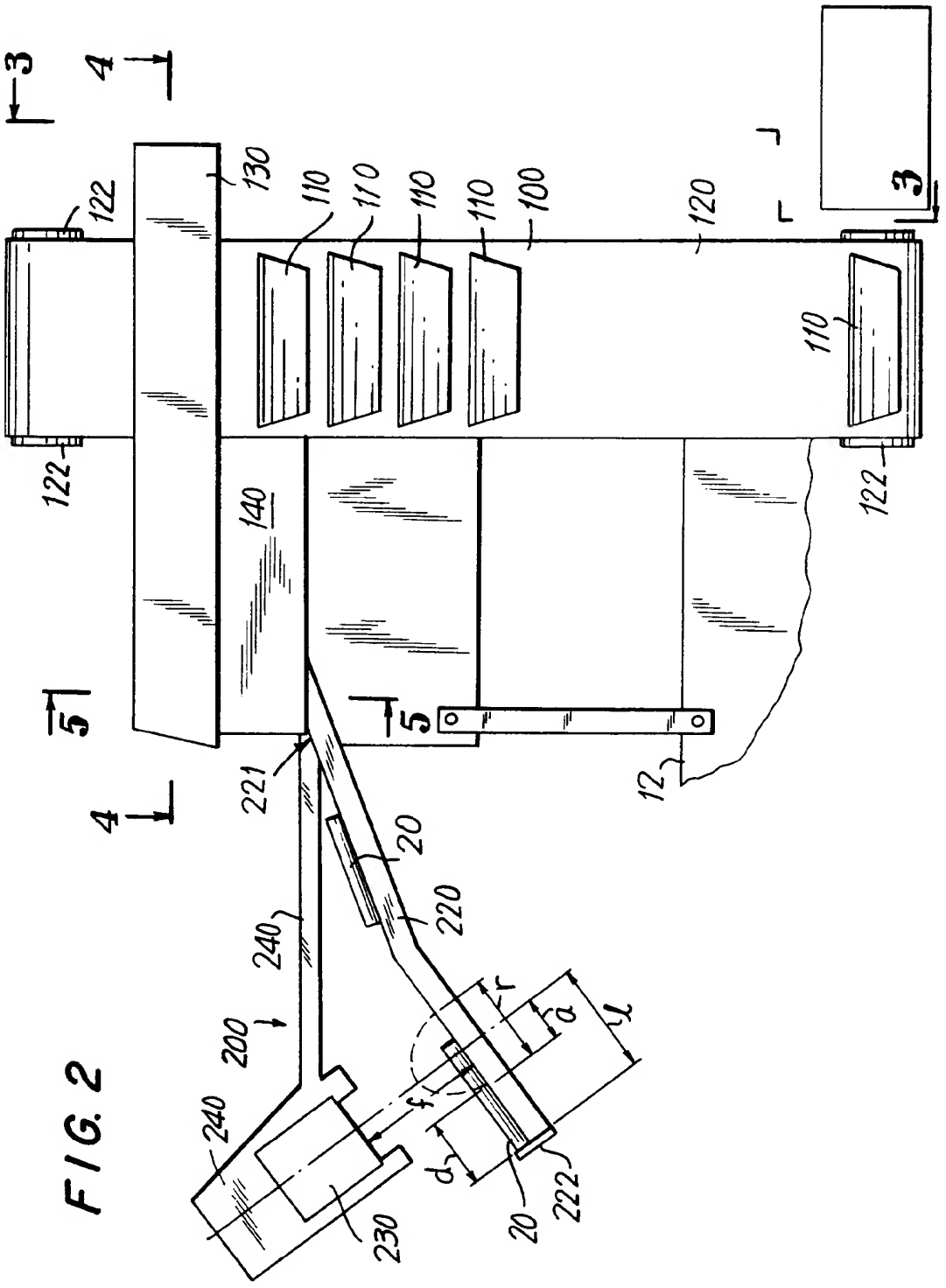

3
4
122
130
110
110
110
110
100
120
3
110
122
122
140
5
5
4
221
20
220
240
200
240
230
20
222
12
r
a
l
d

FIG. 2

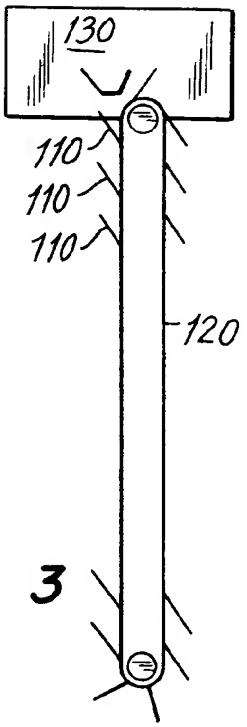


FIG. 3

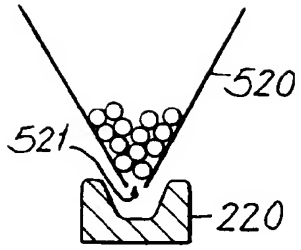


FIG. 5

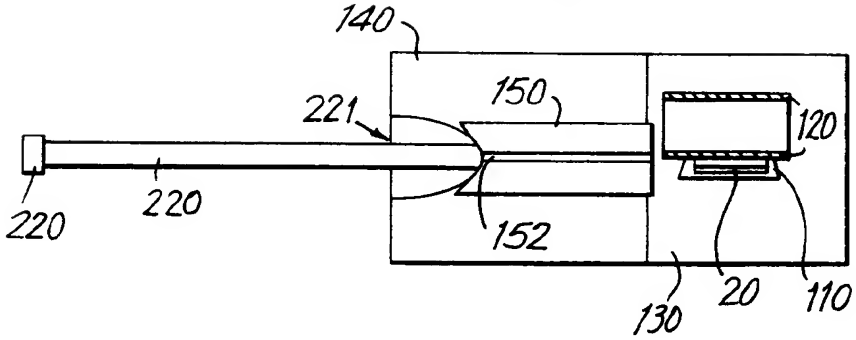


FIG. 4

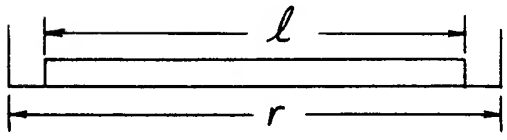


FIG. 6

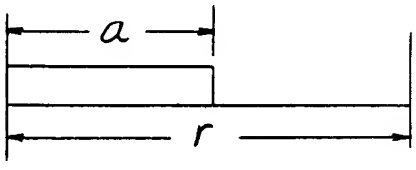


FIG. 7

FIG. 8

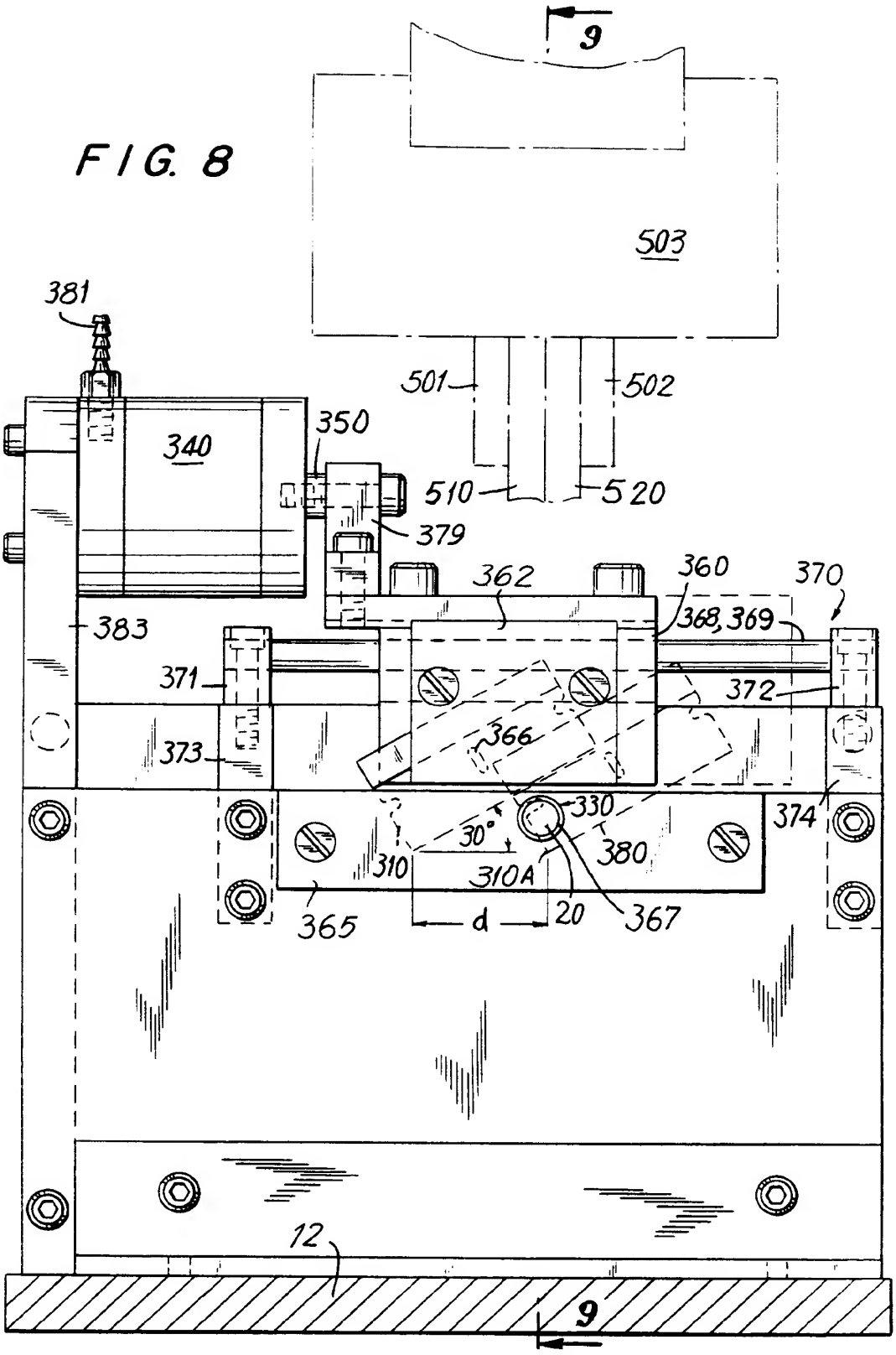
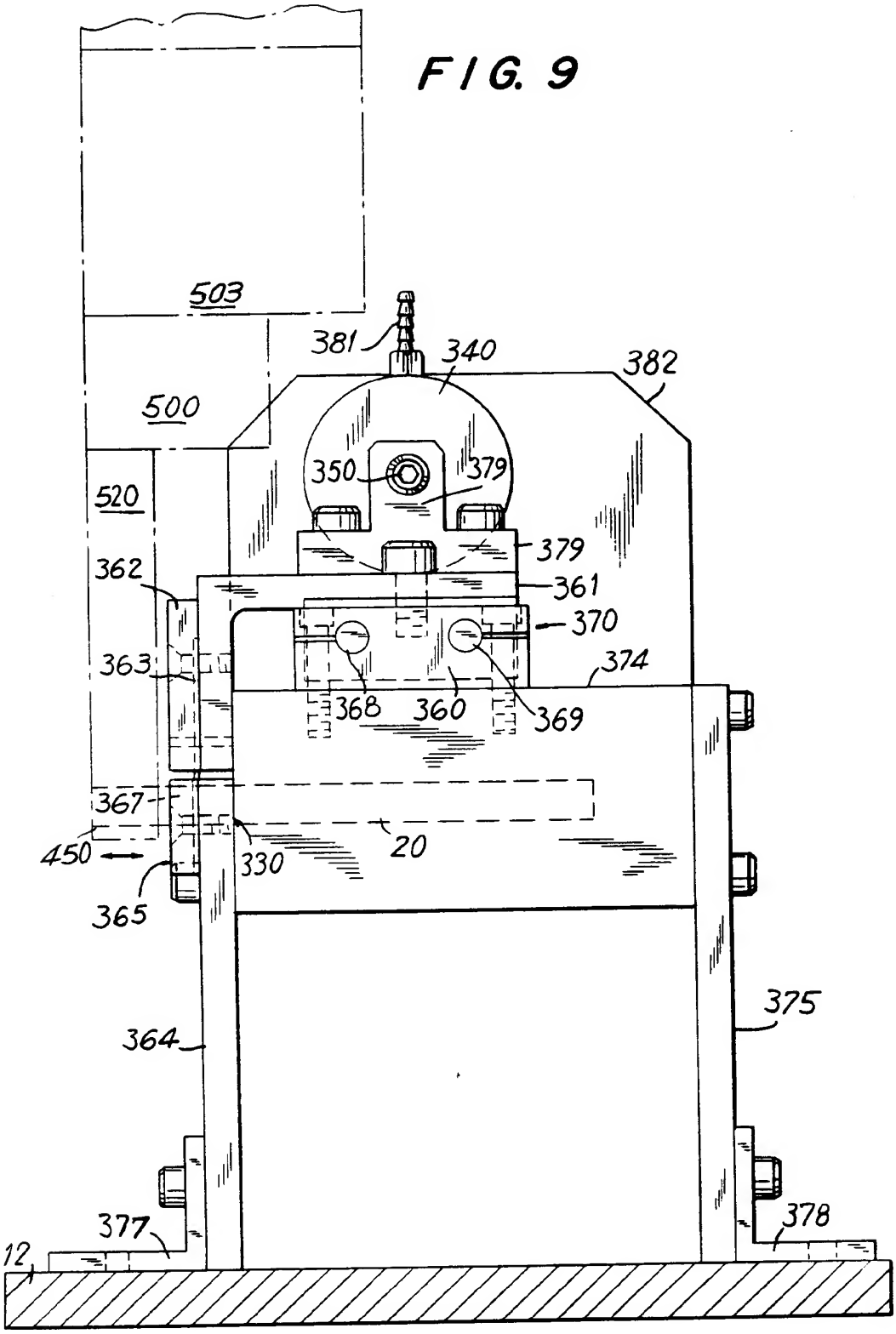

9
503
381
501
502
350
340
510
520
379
362
360
370
368, 369
383
371
372
366
373
330
374
30°
380
310
310A
365
d
20
367
12
9

FIG. 9


503
381
340
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361
370
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374
368
360
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367
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450
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375
364
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378
12

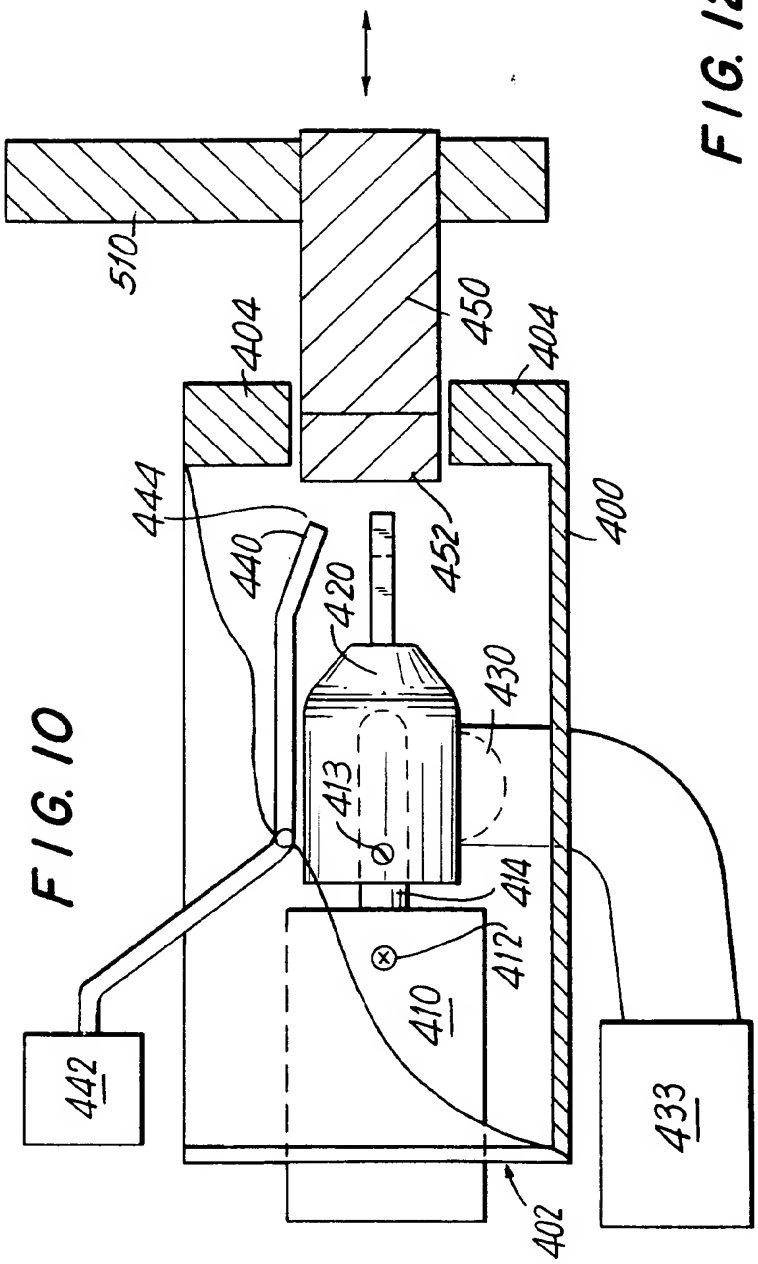


FIG. 10

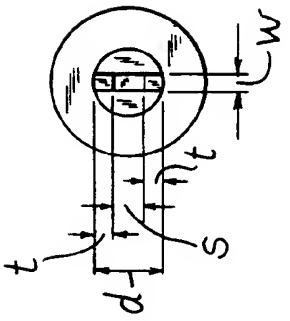


FIG. 12

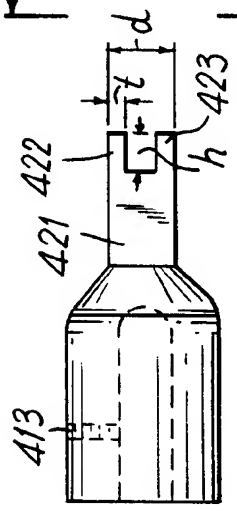


FIG. 11

FIG. 14

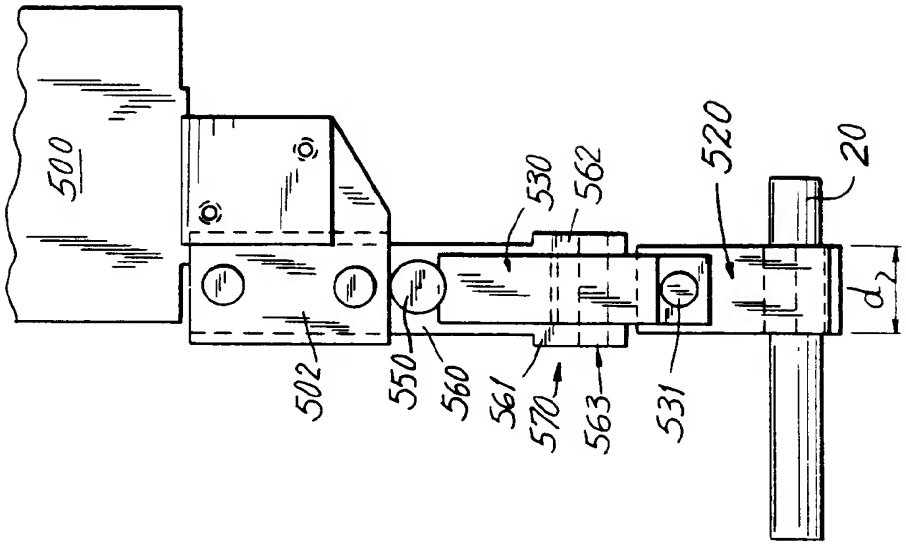
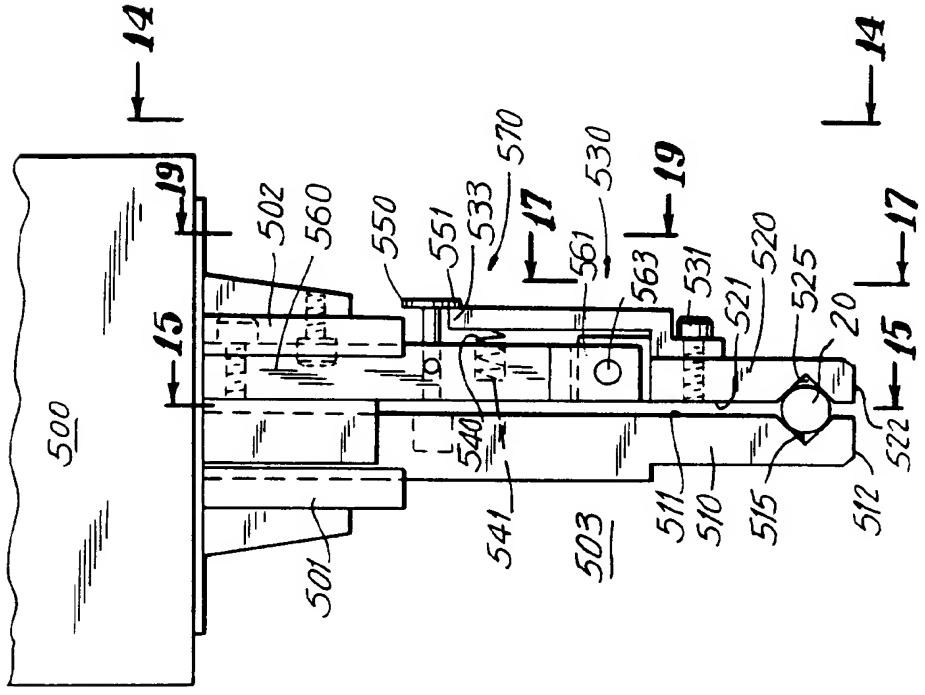

500
502
550
560
561
570
563
530
562
520
531
20
d_2

FIG. 13


14
19
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17
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533
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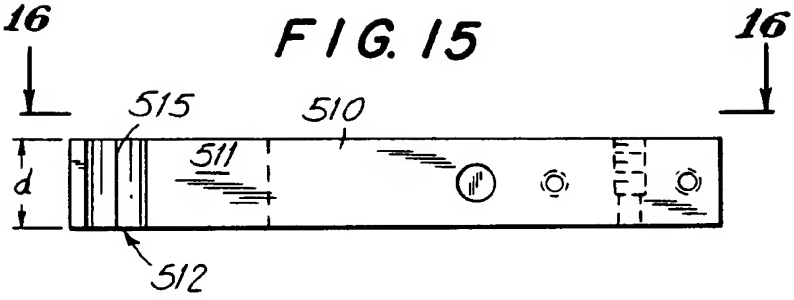
563
531
520
521
525
20
540
541
503
511
510
515
512
522

FIG. 15



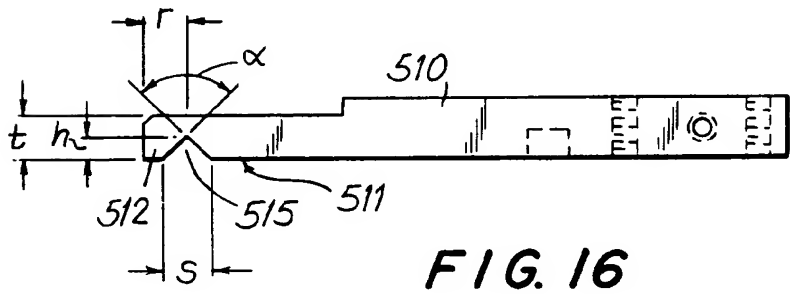
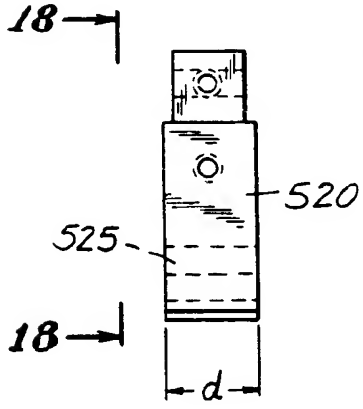


FIG. 16

FIG. 17



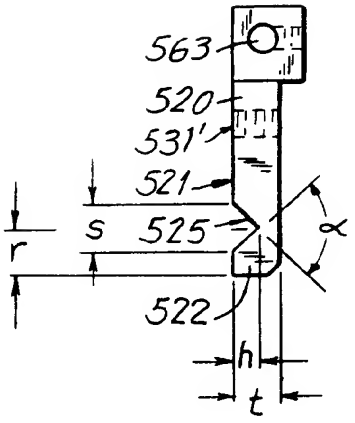


FIG. 18

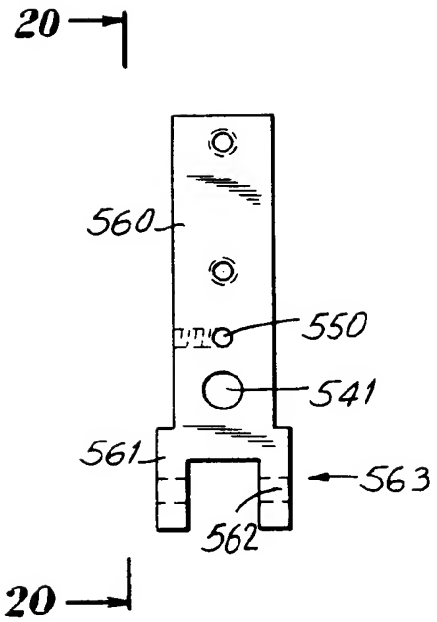


FIG. 19

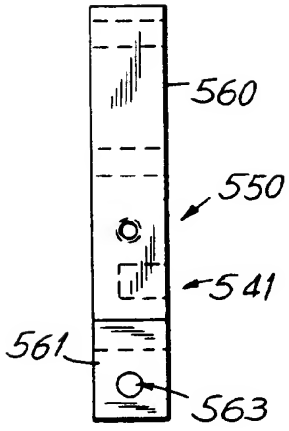


FIG. 20

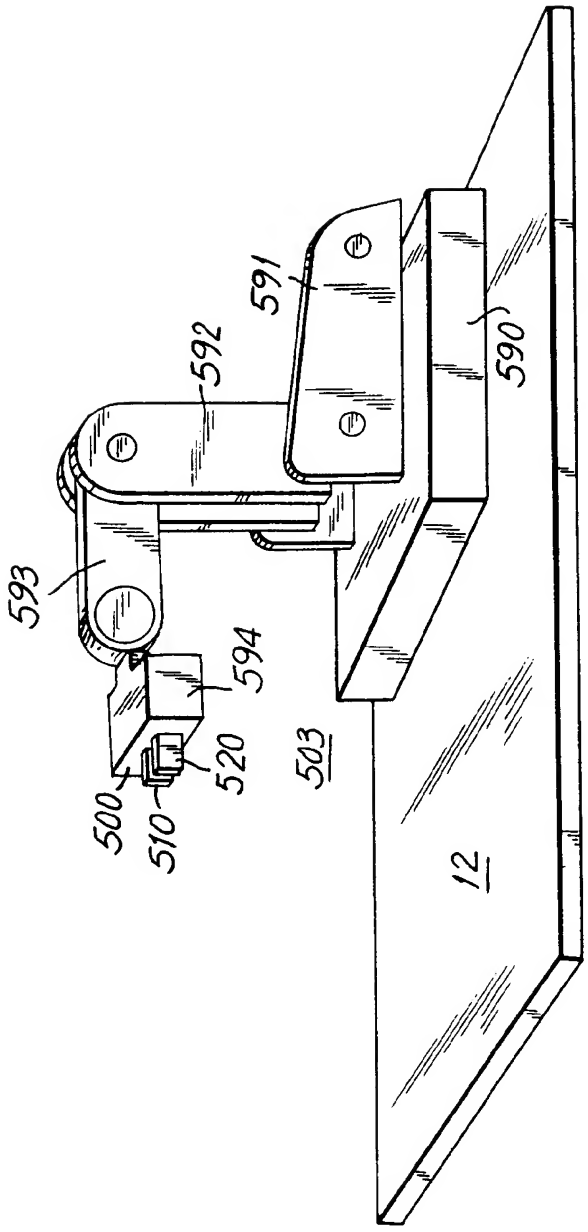


FIG. 21

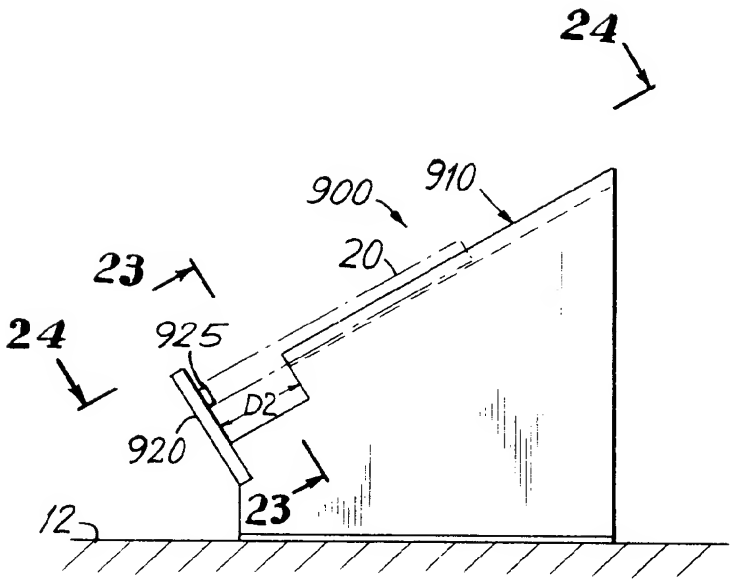


FIG. 22

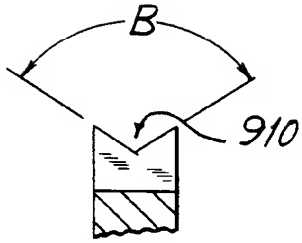


FIG. 23

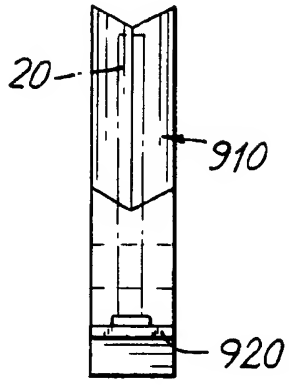


FIG. 24